A GEOGRAPHICAL STUDY OF COAL AND IRON IN CHINA

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WITH AN INTRODUCTION BY

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UNIVERSITY PRESS OF LIVERPOOL LIMITED
HODDER & STOUGHTON LIMITED, LONDON
1926

Made and Printed in Great Britain by C. Tinling & Co., Ltd.,
Liverpool, London and Prescot.

AUTHOR'S NOTE

In the spelling of Chinese names, the forms adopted by the Permanent Committee on Geographical Names (Royal Geographical Society) are adhered to as far as they go. For the rest, there is a general coincidence in spelling on all maps published in China, whether those of the Chinese Geological Survey or those of the Far Eastern Geographical Establishment. Where the name has been changed under the Republic, the old form, being the more familiar, is retained.

The two maps in the pocket at the end require a word or two of explanation. The map of North China has been prepared partly from Richthofen's "Atlas von China" and partly from maps scattered through the publications of the Geological Survey of China. The map of South China has been based on the Geological Map of South China of the Tokyo Geographical Society, which gives the age and the lithological character of the rocks but does not differentiate coalmeasures as such. Only those zones of appropriate age and lithological character where coal is known to occur are marked as actual coalfields, although the coalmeasures may or may not be co-extensive with the area so marked. It is essential to bear in mind these differences in the nature of the two maps.

Among all those to whom I owe a debt of gratitude I must distinguish Professor Roxby, who first suggested these investigations to me, who has throughout inspired them and who has made their publication in this form possible.

W. S.

July, 1926.

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INTRODUCTION

China is beginning to occupy a large place in the thoughts of the Western peoples. This is certainly not due to any profound interest in the details of the Civil Wars which few understand, but to a dim consciousness that both the internal and external troubles through which the country is passing are, to some extent, indications of the turbulent transition of an ancient civilization and of her entry into the full stream of the World's economic and political life. It is realized that this entry is a fact of supreme significance for humanity, that it denotes a new and critical phase in the relations of East and West, and that in the sphere of both international trade and international politics China is destined to play an immensely important part. The isolation, which for many centuries, and indeed millennia, permitted a vast land of great natural resources, inhabited by a very numerous and talented people, to remain so much a World apart that the great majority of the Chinese hardly even conceived of anything beyond " The Middle Kingdom " and a surrounding fringe of barbarism, is rapidly disappearing. But the results of this isolation remain. They are expressed not only in many misunderstandings and misconceptions which only time and goodwill on the part alike of Westerners and Chinese can remove, but in a widespread ignorance of the conditions of the country itself. That the economic development of China will be momentous is taken for granted, but there is little more than conjecture as to the lines which it will follow and the precise factors which may be expected to affect it. This is perhaps particularly the case in the matter of Chinese mineral wealth and the circumstances affecting its utilization. The survey of the great German geologist and geographer, Richthofen, half-a-century ago gave rise to rather sensational estimates of the mineral resources of China which later investigations did not

confirm, so that at the moment there is a tendency for the pendulum to swing to the other extreme and for a corresponding underestimate of their importance. During recent years, however, in spite of adverse political conditions, the scientific investigation of Chinese resources has made very considerable progress ; especially noteworthy are the preliminary work of the Chinese Geological Survey and the publications of the Chinese Government Bureau of Economic Information.

The object of the present monograph, which has been compiled in the light of all the available data, is essentially to discuss the place of the coal and iron ore supply in the future Economic Geography of China. It is from the Geographical rather than the Geological point of view that it has been written[1] and, consequently, Mr. Wilfred Smith has been particularly concerned with the distributional aspects and with taking all the regional factors into account in estimating the relative economic importance of the various mineral fields and the special uses to which they are likely to be put. These points are carefully examined in connection with the space-relations of the chief mineral areas and the means of communication, actual and potential.

It is hoped that this book may be a contribution to the understanding of an increasingly important aspect of Modern China, and of service to many who are interested in her industrial future and the vast problems which are dependent upon it.

PERCY M. ROXBY,
Professor of Geography in the
University of Liverpool,

August, 1926.

1. The work was originally undertaken as a thesis in the Honours School of Geography in the University of Liverpool. Subsequently Mr. Wilfred Smith held a Research Scholarship and the material was thoroughly revised and condensed into its present form.

Chapter I

THE STRUCTURE OF CHINA IN RELATION TO THE DISTRIBUTION OF COAL AND IRON

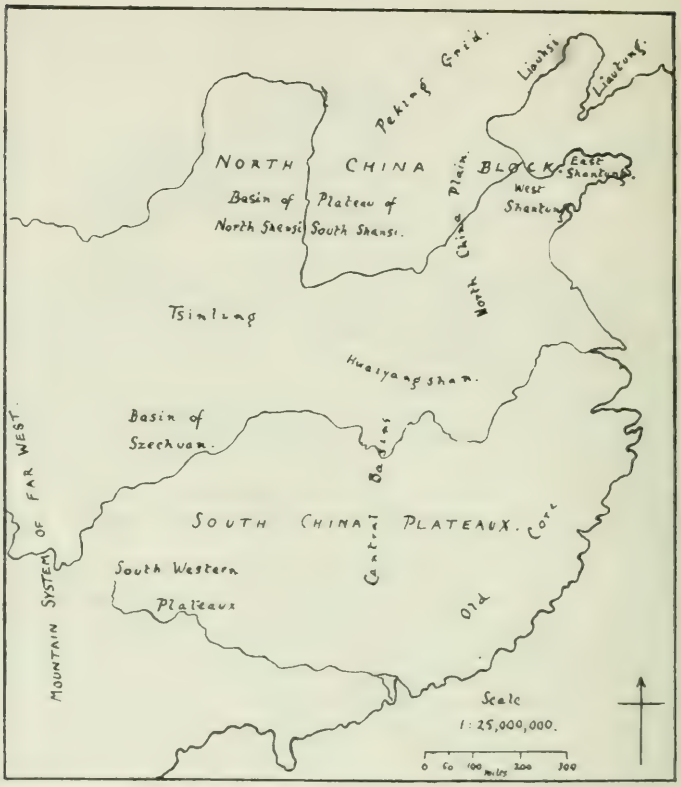
The physical history of China resolves itself into the process, often interrupted and often apparently completed, of the sedimentation of an old geosynclinal bounded on the west by the ancient massifs of Tibet and Gobi and on the east by an equally ancient continent of which only remnants now remain. The filling in of this Chinese basin, as it may be called, seems to have progressed from east to west and the growth of China may, therefore, be represented as having proceeded from an old core in the east. Since the Ordovician North China, unlike South China, has never been deeply submerged and North and South China became differentiated from then onwards.

In the period of the Permo-Carboniferous North China lay on a broad continental shelf and oscillated between land and sea while South China remained deeply submerged. During the succeeding periods of the Mesozoic as far as the Jurassic, North China as a whole consistently formed a land surface and South China in its turn lay on the continental shelf. About the end of the Jurassic the whole of China, apart from the basin of Szechuan, arose as a single continental entity.[1] Conditions suitable to the formation of coalmeasures existed, therefore, in North and Central China during the Permo-Carboniferous and in South China during the Mesozoic.

After this indication of the general difference between North and South China, we are more in a position to analyse the structure of China in some detail.

1. These movements were more in the nature of general elevation and depression and were distinct from folding as such. Folding, the most important since the pre-Palaeozoic, took place in China in different localities in almost every period of the Mesozoic, but was most widespread in the middle. In the Peking Grid it took place in the middle Jurassic, but other regions seem to have been folded somewhat earlier. Along the Lower Yangtze, folding seems to have taken place as late as post-Cretaceous times, although it was probably pre-Himalayan.

THE DISTRIBUTION OF THE COALFIELDS



1.—The Structural Divisions of China.

The distribution of coalfields in relation to the build of China is most easily analysed within the framework of the following broad structural divisions:—

(1) The North China Block.
(2) The South China Plateaux.
(3) The Mountain System of the Far West.

Each of these structural divisions has a distinctive physical history but they are by no means homogenous in structural detail and require sub-division.

THE NORTH CHINA BLOCK

The first major division, the North China Block, comprises both the remnants of the old core (Liautung-Korea-East Shantung) and its early westward accretions, which have constituted a single continental entity, save for local and temporary lapses, since the close of the Ordovician. It corresponds roughly to De Launay's "Faîte Primitif"[1] although it includes the mountain grid to the west of Peking which he would exclude from it. It consists in the main of a series of plateaux and of the stumps of ancient fold mountains which in the matter of relief are separated into two groups by the North China Plain and its extension northwards into South Manchuria. It may be divided into the following structural sub-divisions :—

(1) The Old Core of Liautung, Korea and East Shantung.
(2) The shattered horst of West Shantung.
(3) The Peking Grid of North Shansi and North Chihli.
(4) The Plateau of South Shansi.
(5) The Basin of North Shensi.
(6) The North China Plain.

The surface of the **Old Core** is formed by the fundamental Archaean gneiss-granite platform, whose rocks, though not confined to the old core, nowhere else in the North China Block form the greater part of the surface. On its western flanks in both Shantung and Liautung later sediments have, however, been laid down. Along the western edges of Liautung infolded synclines of Cambro-Ordovician strata have preserved on their floors patches of the Permo-Carboniferous coalmeasures, the largest of which form the coalfields of Penchihu and Saimachi.

West Shantung has the same fundamental platform as the old core and similarly escaped the Jurassic folding, but it is differentiated by its greater thickness of Palaeozoic sediments and by the block faulting to which it has been subject. Suess has aptly summed up its structure by the term "shattered horst."[2] It is traversed by an intricate series of faults running E.-W. and N.W.-S.E., with a secondary series running N.-S. The downthrow side in the main system is invariably on the south and in the secondary system on the west. West Shantung, therefore, consists of a mass of faulted blocks tilted to the north, on the downthrow sides of which occur tilted plateaux of the Cambro-Ordovician limestone and inlaid segments of the Permo-Carboniferous coal-measures.

1. L. de Launay. *La Géologie et les Richesses Minérales de l'Asie*, p. 374, *et seq.*
2. E. Suess. *Das Antlitz der Erde.* English trans., Vol II, p. 187.

The coalfields actually within the highland mass are confined to the belt where the subsidiary system of N.-S. faults has been developed, but they are small and unimportant. The important fields are all distributed around the edges of the highlands and are broken up by the block faulting characteristic of West Shantung. The coalfields of Poshan and Changchiu and possibly also the fields of Weihsien and Ihsien are of this nature. The fields along both the northern and southern edges are in their lower parts increasingly overlain by recent alluvial and loess deposits and it is probable that they extend well out into the Plain.

Away to the south the old platform gradually rises up from beneath the alluvium to culminate in a bold range, the Muling or Hwaiyangshan, overlooking the Yangtze Valley. In relief this mountain edge seems to represent the eastern termination of the Tsinling, but its structural relationships with it are not at all clear. Although old rocks, Pre-Cambrian and Cambrian, occupy most of the higher ground where loess and alluvium do not penetrate there are several small infolded synclines of the Permo-Carboniferous coalmeasures. These are especially numerous where the platform sinks low to the south of Shantung.

The Peking Grid[1] of North Shansi and North Chihli offers certain peculiar features which do not attain such an extreme development elsewhere within the North China Block. It consists of a series of anticlinal ridges with Archaean and Pre-Cambrian cores, alternating with broad synclinals filled with Palaeozoic and Mesozoic sediments and folded in the Jurassic.[2] All these features are parallel to each other and trend N.E.-S.W. With it should be coupled the ridges of Liauhsi, the adjoining part of South Manchuria. This series of ridges is not confined to the Peking Grid as such for it persists, although masked on the surface by overlying sediments of Permo-Carboniferous and Mesozoic age, underneath the Shansi plateau.

Its coalfields are distributed chiefly along its eastern edge and in restricted basins within the Grid itself. The largest coalfields along its eastern edge, the Kaiping and Fangshan-Wangping, rest on the flanks of anticlinals whose axes are marked by older rocks. The other coalfields within the Grid itself are found along the edge of the Mongolian plateau as far west as Suiyuan and in the longitudinal trough immediately to the west of the Nankou Range. The largest is the field of the Tatung basin.

The structure characteristic of the Peking Grid persists under-

1. Richthofen described the parallel ridges lying to the west of Peking as a grill or grid. Suess, following him, refers to them as "the grill of Peking."

2. L. F. Yih. "The Geology of the Western Hills of Peking." (*Memoir of the Geological Survey of China*), p. 58.

neath the **Plateau of South Shansi,** though in a modified form and exhibiting a deflected trend.[1] The series of ridges, having Archaean and Pre-Cambrian cores, traversing South-West Shansi probably represents such a southern extension. The ridges, however, become broader and bounded by fault scarps increasingly southwards, which would indicate that they represent horsts as well as folds. These ridges pitch to the south as they become broader and so exercise a decreasing influence on the surface relief. Gently pitching synclines of Permo-Carboniferous strata are distributed between such ridges in the country between the Hwang-ho and the Fen-ho and in the partly warped and partly faulted basins along the Fen-ho itself. These constitute the bituminous coalfield of south-west Shansi.

To the east of the Hoshan ridge, the easternmost of such horsts, lies the anthracite coalfield of South-East Shansi. Its strata are practically horizontal and its coalmeasures, of Permo-Carboniferous age, though capped in the west by Mesozoic sandstones, crop out eastwards on the surface. Richthofen has termed the western part the " Tsin Plateau," and the eastern, where the coalmeasures form the surface, the " Anthracit-Terrasse." The eastern edge of the South Shansi plateau is marked by the Taihangshan which descends to the North China Plain, partly in the form of flexures and partly in the form of step-faults.[2] Along this plateau edge the coalmeasures are preserved only at intervals and the coalfields are all defined by fault lines. Along the foot of the Taihangshan the coalmeasures remain in more continuous belts, but their outcrop is often masked by accumulations of loess and alluvium. In places they seem to dip eastwards underneath the surface of the Plain but elsewhere they are defined on the east by an outcrop of the older limestone.

South of the alluvial plains of the Hwang-ho this regular plateau structure is replaced in West Honan by a series of faulted blocks[3] distributed between Archaean ridges which, trending east-west, link the region with the Tsinling rather than with the Peking

1. Bailey Willis. *Research in China* (Carnegie Institute Publications), Vol. II., p. 175.

2. Wong, however, conceives of the Taihangshan as an anticlinal, unsymmetrical it is true, dipping on both sides beneath the Permo-Carboniferous coaleasuresm, which cap on the one hand the high Shansi plateau and on the other crop out along the edge of the North China Plain. W. H. Wong. " Geology of China." *China Year Book*, 1925, p. 66.

3. The faulted blocks of West Honan and the Hwaiyangshan edge of the old platform (p. 14 supra) have been considered with the North China Block rather than with the Tsinling for, although in relief they represent the easterly continuation of the Tsinling, they do not partake of the Tsinling's anticlinal form. Their coalmeasures, morever, are of the northern facies, whereas those of the folded Tsinling belong to the southern facies (see p. 20 et seq.).

Grid. The faulted blocks are tilted to the north and in their lower portions the Permo-Carboniferous coalmeasures have been preserved. It is probable that the coalmeasures of the northernmost of these faulted blocks and of the southern foothills of the Shansi plateau are continuous underneath the Hwang-ho alluvium. This and the Lushan-Juchow field farther south constitute the most important coalfields.

The Basin of North Shensi is defined on the east by the westernmost ridge of ancient rocks, the Chingtingshan, of West Shansi, on the north by the Ordos plateau, on the south by the anticline of Cambro-Ordovician rocks defining the northern border of the Wei-ho basin, and on the west by the crystalline ridge of the Lupanshan well within Kansu. The Permo-Carboniferous coalmeasures crop out along the eastern and probably also along the the northern and southern margins and a coal horizon of Jurassic age has been encountered towards the centre of the basin. But the whole basin is obscured by thick accumulations of loess attaining an average thickness of 1,000 feet. It is evident that if the coalmeasures do underlie the whole basin it will only be at a very great depth. The sediments of the basin are folded to an appreciable degree only on its margins and the centre consists of a series of monoclinal dips extending for vast distances.[1] By reason of this folding the coalmeasures may locally rise sufficiently near to the surface to permit mining. These structural features, the gentle folding and the surface masking of the folds, have an important bearing on the existence of petroleum resources in the basin.

The subsidence of the **North China Plain** and the faulting of Shansi and of Shantung were caused by the stress set up throughout the rigid North China Block by the development of Tertiary folding and upthrusting on its margins. But, although the North China Plain is clearly a depressed block, it is not necessarily a downfaulted block and its margins seem to be determined as much by downwarps as by normal faults.[2] As the Permo-Carboniferous differs so little stratigraphically in Shantung from its development in Shansi, it would appear that the intervening North China Plain possesses the same series beneath its present surface of alluvium, gravel and loess. Although the matter will remain speculative until borings are made, there is general agreement on the possibility of the existence of coalmeasures beneath the Plain.[3] The existence

1. F. G. Clapp. *Trans. Amer. Inst. Min. Engin.*, Vol. 68, p. 1110.

2. See Bailey Willis, *op. cit.* Vol. I, pp. 81-3, and Vol. II, pp. 105-7.

3. Pumpelly long ago conceived of coalmeasures beneath the Plain and W. H. Wong, the Director of the Geological Survey, is of the opinion that the evidence at any rate *suggests* the existence of coal underneath the alluvium.

of folding underneath its surface, as suggested by the Kaiping anticline well out in the Plain, might raise up the coalmeasures to within a mineable depth.

THE SOUTH CHINA PLATEAUX

Like the North China Block, the South China Plateaux represent a growth westwards from a core in the east, but longer submergence under the waters of the great Tethys Sea and later uplift have given rise to features quite distinct from those of North China. Throughout, the N.E.-S.W. trend prevails and is represented by curved arcs concave to the S.E., unlike those of North China, concave to the N.W. The region has been peneplaned subsequent to the last period of folding, which may in certain localities have been as late as the early Tertiary,[1] to which it has been subject, and has since been re-uplifted. It consists, therefore, of a series of plateaux retaining the general N.E.-S.W. trend. Interspersed among these plateaux are several basins increasing in size westwards, some of which as, for example, the basin of Szechuan and the basin of Hupeh, have been in existence for long geological ages but others, such as the Poyang lake basin and probably the Tungting lake basin, as distinct from the basin of Hupeh, were formed much later. This major division of the South China Plateaux consists of the following structural sub-divisions :—

(1) The Old Core of the south-east.
(2) The Central Basins.
(3) The South-Western Plateaux.
(4) The Basin of Szechuan.

The Old Core exhibits an extreme development of igneous rocks which occupy most of the surface of the south-east coastal provinces and differentiate it from the older core of the north-east. The trend lines are unmistakeably N.E.-S.W. and the coalmeasures are localized in well-marked synclinals following this trend and generally, though not invariably, forming longitudinal valleys.

Along the western margins of the core the trend becomes E.N.E.-W.S.W. rather than true N.E.-S.W., and is paralleled by the coast of Kwangtung. This feature is especially well-marked along the watershed between the Kan and the Siang, and several of the left bank tributaries of the Kan flow along synclinals of the Permo-Carboniferous between ridges of older rocks.

1. L. F. Yih and C. Y. Hsieh. "The Structure and Physiographic History of the Yangtze Valley." *Bull. Geol. Surv. China*, No. 7.

The Central Basins constitute a transition zone between the old core and its margins of the south-east and the plateaux of the south-west. The most important of these basins are, firstly, the Central Basin of Hupeh itself, secondly, the Hsiangtan basin separated from the foregoing by the early Palaeozoic rocks around the Tungting Lake, and thirdly, the Hengchow-Leiyang basin of upper Hunan. All three persisted well into the Triassic and in part into the Jurassic, and they all tended to stand low during the Tertiary when red sandstones were laid down around their margins. They possess coalmeasures of Permo-Carboniferous and Rhaetic age.

The South-Western Plateaux constitute a distinct and homogenous unit and as such comprise Kweichow, Western Hunan, Kwangsi, eastern Tongking and south-eastern Yunnan.[1] They form massive plateaux of Permo-Carboniferous, Triassic and Jurassic sediments tilted to the east and sloping down to a platform which is probably continuous with the old core. These plateaux have imposed on them folds of great amplitude, pronounced, however, only in the extreme west.

The Basin of Szechuan apparently escaped the Mesozoic foldings and remained a lake basin perhaps into the Tertiary. Coalmeasures of Rhaetic-Lias age crop out along the margins and extend towards the centre of the basin. As the Cretaceous is involved, the folding of its Mesozoic sediments was post-Cretaceous and so may be linked up with the Tertiary period of mountain-building. Although the N.E.-S.W. trend in general prevails, indicating a resuscitation of the ancient trend, the southern end of the fold system becomes almost N.-S. in harmony with the N.-S. trend of West Szechuan and Yunnan, and its northern end almost E.-W. in harmony with the similar trend of the Tapashan.

In the south-east of the basin the limestone of the middle Trias is regularly exposed along denuded anticlinal ridges and the upper Cretaceous is still preserved in the complementary synclinal valleys. The Rhaetic-Lias coalmeasures here, therefore, crop out along the valley slopes and extend underneath the valley floor. The coalmeasures rise along the northern rim of the basin from beneath the plateau of Cretaceous red sandstones and shales of the centre and are cut off on the north-west by a fault scarp marking the division between the gneiss-granite highlands and the Mesozoic basin. Although masked on the surface, the folds persist throughout the rest of the basin, so that, if coalmeasures do exist on its floor they will be lifted nearer the surface and perhaps to within a mineable depth.

1. M. V. Leclère, "Sur la Géologie de la Chine méridionale," *Comptes Rendus Académie des Sciences*, Vol. 131, p. 969.

These structural features have an important bearing on the existence of petroleum and natural gas resources in the western part of the Red Basin. The basins of North Shensi and of Szechuan possess certain similar features of structure and it is significant that they are the only two regions in China which offer petroleum possibilities.

THE MOUNTAIN SYSTEM OF THE FAR WEST

The high mountain country of Far Western China is but the eastern part of the mountain system lying between the stable masses of Tibet and the Deccan to the west and to the east of the cores of South China and of Indo-China.

Its precise structure and its tectonic relationships have not yet been fully determined. In the conception advanced by Deprat vast overthrust sheets and old blocks, perhaps upthrusted and incorporated into them, play as important a part as in the Alps of Europe. The "Alps" of West Szechuan over-ride the Yunnan sheet which itself over-rides others eastwards and is arranged in the form of an arc concave to the South China Plateaux. This vast and intense overfolding, produced by a series of thrusts from the west and north-west, is assumed by Deprat to have been contemporary with the folding of the Himalayas. But since this high mountain country is now characterised by a mature plateau surface cut into by deeply entrenched valleys, it would seem to be older than the Himalayan fold mountains. Its folding was conceivably contemporaneous either with the Mesozoic foldings so widespread in China or with the post-Cretaceous but pre-Himalayan folding of the lower Yangtze Valley, although Gregory would couple it with the Hercynian of Europe of post-Carboniferous times. He, however, attempts to trace the continuation of the E.-W. Himalayan folds across this mature highland, whose own folds are directed N.-S.

The Alps of West Szechuan are constituted in the main of old crystalline rocks and are conceived by Legendre to represent a southward prolongation of the Tibetan massif.[1] In any case, they offer few possibilities for the existence of coalmeasures. Farther south, Yunnan seems to be occupied entirely by Palaeozoic and Mesozoic strata. The Mesozoic rocks are most prominent in the Red River basin and the Palaeozoic in the somewhat higher land on either side. There are coalmeasures of Carboniferous age in the Palaeozoic and of Rhaetic in the Mesozoic.

It seems best to couple the Tsinling with this intensely folded mountain system. The Tsinling is at any rate distinct from both

1. A. F. Legendre. *Massif Sino-Thibétain.*

North and South China and it functioned in a very important way throughout geological history as the barrier between them. Moreover, although folded in several previous geological epochs, the Tsinling was uplifted and perhaps arranged into its present anticlinal form by the mountain-building movements of the Tertiary. The western Tsinling as distinct from the faulted blocks of its eastward extension comprises two anticlinals, the Tsinling proper and the Tapashan, separated by the synclinal of the upper Han Basin. Each of these major features includes innumerable minor folds. Coalmeasures crop out in the Han synclinal and in the Tapashan anticlinal but, although of Permo-Carboniferous age, they are akin to the southern rather than to the northern facies.

STRATIGRAPHICAL CONSIDERATIONS

The Permo-Carboniferous system in China has two distinct facies, the continental facies of North China and the marine facies of South China. This distinction is not, of course, absolute, for the continental facies contains occasional limestone horizons and the marine facies occasional terrigenous deposits.

The continental facies itself may be divided into two main series. The lower is of alternating limestones, ferruginous shales, sandstones and fireclays with occasional thin coalseams. The Geological Survey of China term it the "Taiyuan" series and attribute it to the late Lower Carboniferous. The upper series forms the productive coalmeasures laid down during the period of the actual transition from the Carboniferous to the Permian. The Geological Survey restrict the term "Shansi" to this series. A succession of current-bedded sandstones, persisting well into the Mesozoic, almost invariably overlies the "Shansi" series. Throughout the coalfields of North China these features, particularly the horizons of the ferruginous shales and of the main coalseam, are peculiarly persistent and nowhere differ greatly. Particular horizons may, of course, locally disappear and the main coalseam does not attain elsewhere the consistent thickness of South Shansi.

The marine facies is, as might be supposed, generally devoid of coalmeasures but its limestones may in certain of its phases be replaced by coal-bearing sandstones and shales. In South-West China the early Carboniferous has coalseams analagous to those of the "Taiyuan" series of North China, and in East Central China the transition from the Carboniferous to the Permian is marked by sandstones and coal-bearing shales contemporary with the "Shansi" series of North China. This persistence into the Permian, more marked in South and Central than in North China, links the Chinese coalmeasures with the similarly Permo-Carboniferous coal-

measures of India and of Siberia rather than with the Carboniferous coalmeasures of North America and Europe, which show no such persistence into the Permian.

In several basins in Central China coal-forming conditions persisted long after the Carboniferous and in certain of them even after the Permian. The coalmeasures of the basins along the Siang corridor are of Permian age with local developments, as at Pinghsiang, of coalmeasures of the Rhaetic-Lias period. The plateaux of South-West China have subsidiary coalseam horizons of mid-Permian and early Trias age in addition to the main Rhaetic coalmeasures. They represent the general transgression of shallow water conditions as distinct from the development of the coalmeasures in situ within the isolated basins of Central China.

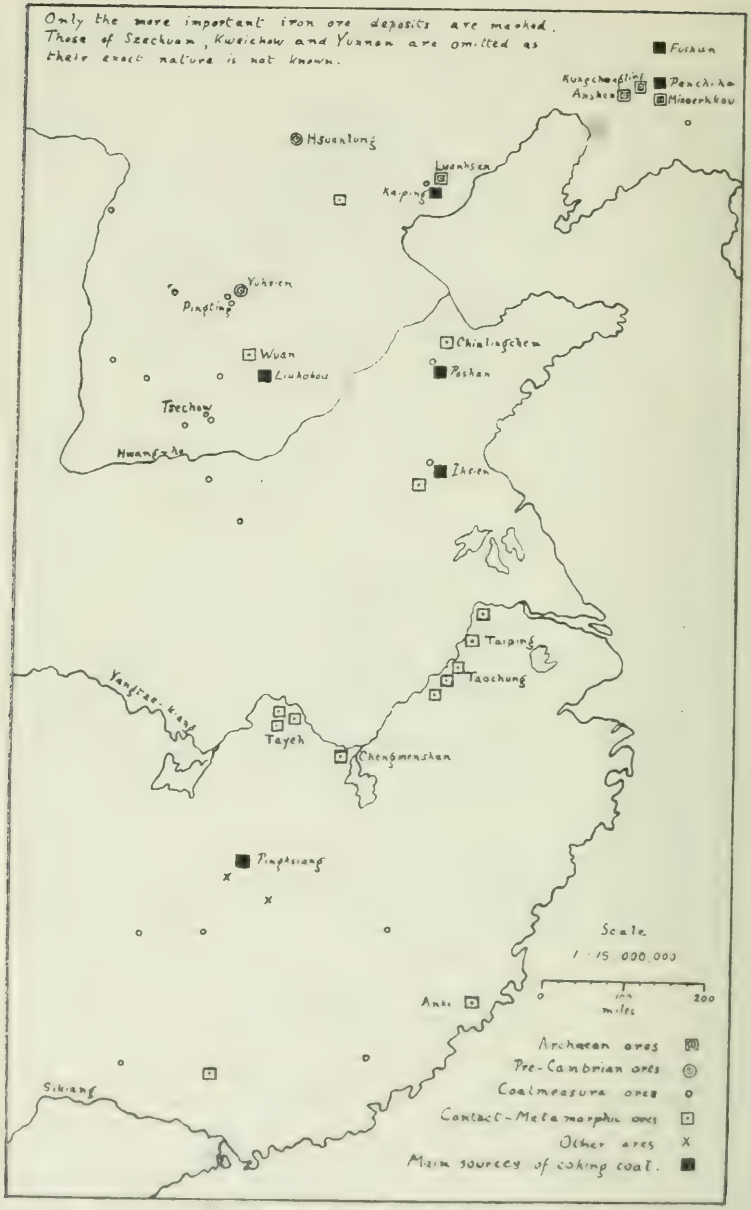
The second great epoch of coalmeasure formation in China was that of the Rhaetic, marking the transition from the Trias to the Jurassic. The Rhaetic coalmeasures were laid down along the continental shoreline rising from the ocean which had enveloped South-West China for most of the time since the middle Carboniferous. In the succeeding Jurassic coal-forming conditions remained only in isolated lake basins, which then existed in North as well as in South China. Such a persistence into the Lias is analogous to the similar earlier persistence into the Permian.

The coalmeasures of the Rhaetic-Lias period may be divided into two distinct regional developments, the one of the isolated and generally small Jurassic basins scattered throughout North-East and South-East China and the other of the much larger and more continuous coalfields of South-West China and Tongking. Such coalmeasures of North China are of Liassic rather than of Rhaetic age, whereas in South-West China they are Rhaetic rather than Lias. In the basin of Szechuan alone does the Rhaetic persist into the Lias.

China had become distinctively continental long before the beginning of the Tertiary so that the conditions suitable to the formation of Tertiary coals were limited to a few small isolated lake basins which are, however, more numerous than was at first supposed. The best known is the Fushun field of South Manchuria.

THE DISTRIBUTION OF THE IRON ORES

Although intimately bound up with the structure of China, the distribution of iron ores is necessarily different from the distribution of coalmeasures, for iron, unlike coal, is found in rocks of all geological ages and of every lithological character. The term " iron ore " can hence be applied only to those rocks whose proportion of iron is sufficiently large to permit of their



2.—The Distribution of the Different Types of Iron Ores.

economic utilization. The improvement of metallurgical processes renders utilizable iron-bearing rocks with a lower and lower proportion of metallic iron, and the application of the term " ore " is therefore continually extending.

Iron ores may be divided, according to their origin, into two classes : the first of sedimentary ores formed contemporaneously with the encasing strata and, therefore, in a manner similar to coal-seams, and the second of ores occurring like the other metalliferous ore bodies in intimate association with intrusive igneous rocks. Some geological periods have been more favourable to the accumulation of iron ores, as of coalseams, than others. It is generally accepted that the most favourable conditions for the formation of sedimentary iron ores are afforded by long periods of leaching and chemical denudation which operate particularly in base-levelled regions.[1] The ores associated with igneous intrusions are formed in those periods when igneous activity, a normal accompaniment of mountain-building movements, is at its maximum. De Launay, therefore, insists on the correlation of structural regions and metallogenetic provinces. The sedimentary ores have always a great horizontal extent but the ore beds are often very thin. The ores developed in association with igneous intrusions, on the other hand, have only a limited horizontal distribution but usually occur in compact masses.

The iron ores of China may be classified in the way indicated above into the two main categories of sedimentary and metamorphic. The more important types of the sedimentary ores in China are banded ores in crystalline schists, coalmeasure ores and oolitic ores. The coalmeasure ores occur as nodules and lenses in beds whose thickness always varies greatly. They form an integral part of the " Taiyuan " series of the Permo-Carboniferous of North China and of the Rhaetic coalmeasures of South China. Sedimentary oolitic ores form important deposits in the Pre-Cambrian of Chihli and its borders, but are not yet known to occur elsewhere. Banded haematites and magnetites are distributed widely throughout the crystalline schists of South Manchuria and North-East Chihli. They are similar in type and age to those of Scandinavia and of the Lake Superior region, where huge masses have been concentrated along tectonic axes. The ore bodies of Liautung are also concentrated, though not to the same extent, along the contact with igneous intrusions.

W. H. Wong distinguishes two major metallogenetic provinces in China.[2] In North China the metalliferous ore bodies are pre-

1. W. H. Emmons. *Principles of Economic Geology*, p. 295.

2. W. H. Wong. " Les Provinces Métallogèniques de Chine." *Bull. Geol. Surv. China*, No. 2.

dominantly ferreous and its metamorphic iron ore bodies occur in intimate relationship with intrusive igneous rocks of the grano-diorite group. In South China the metalliferous ore bodies are predominantly non-ferreous and the igneous intrusive is granite rather than grano-diorite as in North China. The period of igneous intrusion was the same in either case, being definitely post-Carboniferous and pre-Jurassic, but the composition of the magmas from which the ores were deposited must have been essentially different.

Magnetite-haematite iron ore bodies occur almost invariably in North China wherever grano-diorite is intrusive into pre-existing sedimentary rocks. Although distributed all over North China, they are especially abundant along the line of the lower Yangtze, which seems to have long constituted a zone of weakness between the ancient platform to the north and the South China Plateaux to the south. These metamorphic ores are especially well-developed when grano-diorite is intrusive into limestone, which may be of Ordovician, of Devonian or of Carboniferous age.

It would follow from Wong's hypothesis regarding the composition of the magma from which the ore deposits of South China originated that the iron ores of South China are essentially of sedimentary origin. Certain iron ore bodies of Kweichow, however, have characters suggesting a metasomatic origin. Further, several magnetite iron ore bodies of the coastal provinces require for their explanation some relationship to igneous intrusions. But in any case metamorphic iron ore bodies are relatively few in South China.

Chapter II

THE REGIONAL RESOURCES OF CHINA IN COAL AND IRON

Although the distribution of the coalfields is intimately bound up with the build of the country, their economic function and significance cannot be appreciated on the basis of the structural divisions as they stand. The nature and orientation of their development are directed rather by those physical and human factors which interact within a geographical region. Further consideration of coal and iron is, therefore, based on a division of China into natural or geographical regions,[1] each of which possesses some unity of economic life issuing out of the similarity of environment within the region and each of which promises to develop some regional specialization of industry. The following are regions of this nature :—

(1) South Manchuria.
(2) North China.
(3) The Yangtze Valley below the Gorges.
(4) South China.
(5) The Basin of Szechuan.
(6) The High South-Western Plateaux.

These regions are not of equal economic significance nor necessarily of equal distinctiveness.

In the survey which follows some attempt is made to appraise the value of the various coalfields. This is a product not only of the intrinsic character of the fields themselves—their structure, their coal reserve and the quality of their coals—but also of their accessibility to centres of population and lines of communication. The full significance of the latter factor, that of accessibility, will emerge later on. But some statement must here be made regarding the nature of the estimates of China's coal reserves.

The most comprehensive estimates of the coal reserves of China are those of Drake, drawn up for the International Geological

1. These are natural regions in Professor Roxby's sense and geographical regions in Professor Unstead's sense, but they are treated here from the restricted point of view of their economic function. See P. M. Roxby. "The Theory of Natural Regions." *Geographical Teacher.* Summer, 1926.

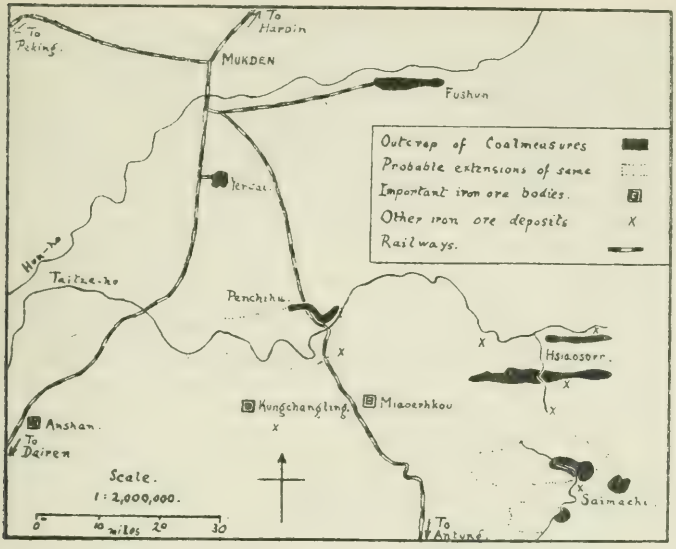
Congress of 1913, and those of the Geological Survey of China. The estimates of Drake are based on seams one foot and over in thickness and assume a mineable depth of 4,000 feet. The estimates of the Geological Survey include only those seams three feet and over in thickness and take into account a mineable depth of 3,000 feet. The Geological Survey estimates China's coal reserve at 23,435 million tons but Drake at 996,618 million tons. The differences between these two estimates are enormous and out of all proportion to the differences in the basis of calculation. The estimate of the Survey is professedly conservative but it is being continually amplified by the investigations of its own staff.[1] The bulk of Drake's huge total consists of intelligent guesses at the reserves of the lesser known fields, undoubtedly of great extent and importance. Although he acknowledges that his estimates of some fields may be too large and of others too small, Drake considers that, as a whole, they represent a fair estimate of China's coal resources and that they are more likely to be increased than decreased by future investigations. Drake's estimate may perhaps be taken to represent the possible reserve, which is necessarily largely hypothetical, and the Survey's to represent a conservative view of the actual reserve, about which there can be no dispute.

SOUTH MANCHURIA

South Manchuria is distinct from the rest of North China, of which it structurally forms a part, because of its position on the fringes of the Chinese culture area but more particularly because of the overshadowing of its development by Japan. These features of divergence have arisen in the main out of the position of the region as the gateway into North-Eastern China.

Its coalfields are all in scattered basins, distributed in the main in two groups, flanking either side of the South Manchurian Lowlands, towards which the life of the region gravitates. The most important fields along the eastern margins of the Lowlands, that is, the edge of the Liautung massif, are Fushun, Yentai, Penchihu and Saimachi. In the west, coalfields are distributed along the edges of the highlands and behind them in the upper Taling-ho basin draining into the Lowlands. The eastern fields are better known than the western and the relative future importance of the two groups cannot, therefore, be gauged.

1. Including thinner seams and allowing a greater depth, the Survey admits of a total reserve of 40,000-50,000 M.T. These estimates were made a few years ago. W. H. Wong, however, has recently stated that it is the general opinion of those familar with Chinese coal resources that this figure should at least be doubled, making a reserve, therefore, of about 100,000 M.T. (*China Year Book*, 1925, p. 122).



3.—Coal and Iron in South Manchuria.

The **Saimachi** field, although its horizontal seams cropping out along the hillside are comparatively easy to mine, is isolated well within the Liautung massif. Its coalseams are three to five feet thick and yield a bituminous coal which, though coking, is friable and often high in ash.[1] The main seams of the **Penchihu** field, according to Richthofen, are no more than two feet thick and produce coals similar to those of Saimachi. But, situated where the Taitze-ho valley opens out into the Lowlands, it has a much more advantageous location. Its coke, moreover, is well suited for blast furnace practice. The **Yentai** field has seams up to ten feet thick which yield a semi-anthracite fairly low in ash but often sulphurous. Both the Penchihu and the Yentai as well as the Fushun field are accessible from the trunk railway lines. The

1. The minimum workable thickness of a coalseam varies with regard to its situation for mining and with regard to the quality of its coal. In the Lancashire coalfield in the case of good quality coal, a seam one foot thick is considered workable only when it can be mined by an adit driven in from the outcrop and the expense of sinking a shaft to mine an underground seam is considered justifiable only when there is more than one seam at least two feet thick. In China the labour costs of winning a given quantity of coal are less than in this country so that the above considerations are not immediately applicable. In what follows, a minimum thickness of three feet has been assumed as desirable in the case of underground seams yielding medium quality coals, but where the coal is of better quality or particularly easily mined, thinner seams are certainly economically workable.

mainseam of the Tertiary **Fushun** coalfield is 50 to 180 feet thick, increasing up to 430 feet in the west where it is adapted to open quarrying. Where the coal is of coking quality, however, the seam is faulted down 2,000 feet below the surface. Fushun coal is a sub-bituminous lignite, low in ash and high in volatiles with an important percentage of nitrogen. The reserve of the Fushun field is now estimated at round about 1,000 million tons of which about half is adapted to open cut methods. The Yentai field has a reserve of about 20 million tons and the Penchihu field, according to Inouye, of 180 million tons.

Immediately west of the crest of the Liauhsi ridge there are several coalfields each of which has an aggregate coalseam thickness of thirty feet or over, made up of seams at least three feet thick.[1] Their coals in the main are bituminous and of good quality and some yield anthracite as well. Drake has estimated the reserves of two of them, **Peipiao** and **Nanpiao,** at 220 and at 400 million tons respectively. Several basins of Tertiary lignites are also found farther within the Taling-ho basin but they are rather smaller than the Permo-Carboniferous fields and lenses of sand are common within their coalseams. On the basis of Drake's estimates the total coal reserve of these western margins of the Lowlands would amount to about 1,000 million tons.

The Liautung massif constitutes an important iron ore field consisting in the main of ores bedded in crystalline schists. They extend in a zone right across the peninsula along the line of the watershed between the Hun-ho and the Yalu. In the east, though consistently three feet thick and having an iron content of 50 per cent., the ore beds are discontinuous and attempts to work them have failed. Towards the west, in the vicinity of igneous intrusions the beds are much thicker and the ores richer. They are, therefore, much more suited to economic utilization. Still farther west, there are larger ore masses several hundred feet thick, comprising the bulk of the ore reserve and adapted to working by open cut methods. But, although containing bodies of richer ore, they are predominantly low-grade, having an average iron content of only 35 per cent., and, being highly siliceous, demand some preliminary concentration. The three largest of these ore masses, **Anshan, Kungchangling** and **Miaoerhkou,** are all accessible from the trunk railway lines. The total reserve of these Archaean ores of Liautung is estimated at 740 million tons,[2] of which less than 300 million tons are considered as workable under present conditions.

1. These coalfields, though within Chihli province, function in their economic life as part of South Manchuria.

2. Of this total Anshan possesses 400, Kungchangling 268 and Miaoerhkou 70 million tons. E. R. Tegengren, "The Iron Ores and Iron Industry of China" (*Mem. Geol. Surv. China*), Part II, p. 287, *et seq.*

NORTH CHINA

The economic unity of North China is expressed through the North China Plain around which its coalfields are distributed and towards which they gravitate. These coalfields are, however, diverse in character and in space-relations and their utilization will lead, therefore, to diversity of function. Hence it seems best to consider the coalfields of North China as falling into the following groups :—

(1) The Peking Basin.
(2) The Peking Grid.
(3) North Shensi.
(4) South Shansi and the adjacent parts of the Plain.
(5) North Shantung.
(6) The South-Eastern Quadrant of the North China Plain.

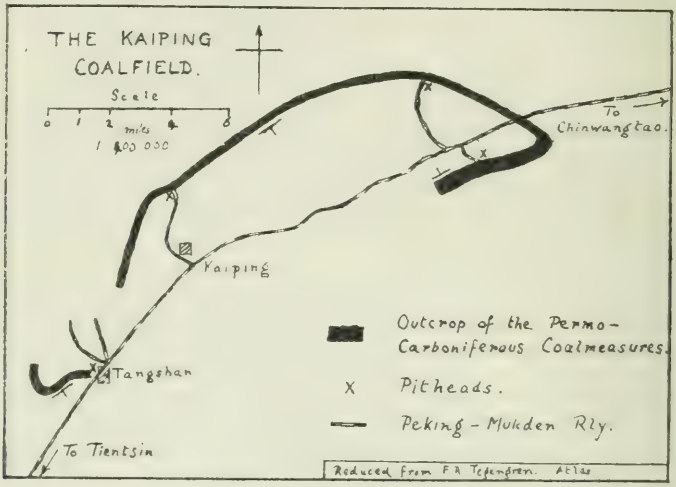
The Peking Basin.

The largest coalfields of the Peking Basin, the Kaiping and the Fangshan-Wangping, are both within easy reach of Peking, at once the capital and the focus of the Chinese railway system, and of Tientsin, the commercial centre of North China. There are smaller fields on either side, such as the anthracite field of Shihmenchai just within the Great Wall having a reserve of 100 million tons and as the tiny Lingshan field away to the south-west along the foot of the Hengshan, having a reserve of only 30 million tons.

Although the **Fangshan-Wangping** coalfield has a great vertical development of the coalmeasures, comprising both the Permo-Carboniferous and the Jurassic, and a reserve of the magnitude of 8,120 million tons according to Drake's estimate, it is highly disturbed and its coals are generally of a poor quality. Its industrial future is from these considerations acknowledged to be comparatively insignificant.

The **Kaiping** field of Permo-Carboniferous age seems to take the form of a syncline having a well-defined western wing where it rests on the flank of an anticline but an ill-defined eastern wing out in the Plain. The aggregate thickness of its coalseams is round about 60 feet, the most important seams averaging 7 and 50 feet. Its coals are bituminous and some yield a good metallurgical coke. Its coal reserve has been variously estimated, the estimate of Drake being 2,757 million tons, and it seems probable that the field is larger than was at first supposed. The total reserve of these coalfields of the Peking Basin is somewhat comparable to that of the fields of North Shantung or of the Peking Grid and is by no means of the order of magnitude of that of the South Shansi fields.

All the coalfields of the region have iron ores of the Shansi type but they have no economic importance. Several granodiorite intrusions with ores developed around their margins have been encountered within the Basin, but their exact potentialities have not been explored. Ancient bedded ores similar to those of Liautung are known in the vicinity of the Kaiping coalfield, but, although extensive, they are of low grade.



4.— The Kaiping Coalfield.

The Peking Grid.

The coalfields of the Peking Grid, co-extensive with the structural region of the Peking Grid shorn of its eastern fringes, lie within the series of synclinal troughs between the Nankou range on the east and the edge of the Mongolian plateau on the west. They may be considered as falling within the following main groups: the first of fields scattered along the Mongolian plateau edge; the second, the Tatung basin, the largest and most important field within the Peking Grid; the third of fields along the ridge between the Yuhsien and Sininghsien valleys; and the fourth of fields along the Hun-ho.

Under the edge of the Mongolian plateau several outcrops of the Lias coalmeasures have been traced and scattered basins of Tertiary lignites have been encountered. The most important of the Lias fields is in Suiyuan in the vicinity of the right-angled bend of the Hwang-ho. The Lias coals are both bituminous and anthracite. The Tertiary basins have seams of workable thickness and yield coking coals low in ash.

The lower coalmeasures of the **Tatung** basin belong to the "Shansi" series of the Permo-Carboniferous, but it is here represented by only a couple of seams over three feet thick and these thin out away from the south-east of the basin. The upper coalmeasures, of Lias age, include four seams each with an average thickness in the south of nearly ten feet, swelling locally up to thirty feet, but in the north of little more than three feet. Both the Permo-Carboniferous and the Lias coals are bituminous of good quality, but their coke is not suitable for metallurgical use. The reserve of the Permo-Carboniferous coalmeasures has been estimated by the Geological Survey at 252 million tons and of the Lias at 1,102 million tons.

Lias coalmeasures lie just under the crest of the ridge, often capped by comparatively young lava flows, separating the **Yuhsien** and **Sininghsien** valleys. There are several seams of workable thickness. They yield bituminous coals which are smokeless and low in ash. Their reserve is estimated by the Survey at 438 million tons and a further 1,000 million tons is concealed by the later lava flows.

In the fields grouped around the Hun-ho, the Lias coalmeasures are more intensely folded but they crop out similarly high up towards the crests of the ridges. Their seams are comparable to those of the Yuhsien-Sininghsien field in their thickness and in the good quality of the coals they yield, which are, however, anthracite rather than bituminous. But these Hun-ho fields are all small and have reserves, according to Drake, of but 40-100 million tons apiece.

The most important iron ore deposit of the region—the **Hsuanlung**—is a group of oolitic haematites in the Pre-Cambrian of the hills near to Hsuanhua. These bedded ores, non-phosphoric and of good grade, extend over a considerable area and are adapted to open quarrying. Their reserve is estimated at 92 million tons and they have an iron content of over 50 per cent. An identical ore deposit has been discovered in the Pre-Cambrian in the extreme south of the Peking Grid, near to Pingting of the Shansi anthracite coalfield. But this is of low grade, the best ores having an iron content of barely 30 per cent.

North Shensi.

The Permo-Carboniferous coalmeasures of North Shensi crop out along the left bank of the Hwang-ho after it has left the Ordos plateau. The mainseam of the "Shansi" series around Paotechow attains an average thickness of nearly 40 feet[1] which, unless a

1. C. C. Wang. "Stratigraphy of Paotechow." *Bull. Geol. Surv. China*, No. 4.

purely local development, is thicker than in the South Shansi fields. Its coals are bituminous. The bituminous coals of the northern rim of the North Shensi basin appear to be of good, but the Rhaetic-Lias coals of the centre only of poor, quality. The Wei-ho valley, being outside the loess-filled basin of North Shensi, has no coal resources of its own but there are small scattered fields beyond it in Kansu. The Survey estimates the coal reserve of Shensi at 1,000 million tons, most of which belongs to North Shensi. Drake estimates the reserve of North Shensi at the same figure.

The iron ore beds occurring at the base of the "Taiyuan" series along the left bank of the Hwang-ho are considerably thicker than elsewhere in Shansi. Although the ore, a haematite, is of comparatively low grade, these beds may be more valuable than the thin ore beds of the South Shansi fields.

South Shansi.

The coalfields of South Shansi and of the adjoining parts of the Plain fall into three divisions. There is, firstly, the bituminous field of the west extending in basins between the ridges almost as far west as the Hwang-ho. The anthracite field of the east, separated from the foregoing by the horst of the Hoshan, stretches eastwards to the very edge of the plateau. There is, thirdly, beyond the plateau the coalfields along the foot of the Taihangshan.

The coalseams throughout the **bituminous field** are almost horizontal and, often cropping out along the hillsides, are easily mined. The seams of the "Taiyuan" series are all thin, rarely exceeding three feet, and yield an anthracite coal of but medium quality. The mainseam of the "Shansi" series has an average thickness of 16 feet which is slightly less than in the anthracite field. The coals of the mainseam, being bituminous, give the general character to this western field and distinguish it from the eastern anthracite field. The bituminous coals are again only of medium quality, being often sulphurous and high in ash. The size of the bituminous coalfield was exaggerated by Richthofen who conceived of the N.-S. ridges simply as limestone scarps breaking up an otherwise continuous coalfield. The coalmeasures, however, appear to be confined to basins between dominant N.-S. ridges. Drake, following him, also over-estimates its size when he attributes to it a reserve of over 250,000 million tons.

The coalmeasures of the **anthracite field** are throughout horizontal until the Taihangshan plateau edge is approached. They are in the west—Richthofen's "Tsin Plateau"—overlain by Mesozoic sandstones, 1,000 feet thick, and in addition by an undetermined thickness of loess. Shafts would hence have to be sunk through at least 1,500 feet of unproductive strata before the

mainseam could be reached. In the east—the "Anthracit-Terrasse"—the coalmeasures crop out on the surface and permit easy mining. The "Shansi" series predominates almost everywhere within the anthracite field and the thin coalseams of the lower "Taiyuan" series have very little economic significance. The thickness of the peculiarly persistent mainseam varies between 10 and 40 feet with an average of 18 feet on the "Anthracit-Terrasse." The aggregate coalseam thickness amounts to 60 feet at the maximum and 30 to 40 feet on the average. The coal yielded by the mainseam on the "Anthracit-Terrasse" is a hard and pure lump anthracite, smokeless and low in ash. Its solidity would equip it for use in a blast furnace, but its steam-raising powers, as expressed in calories, seem to be peculiarly low for a coal of its quality. Nyström, however, is of the opinion that on the "Anthracit-Terrasse" away from the north-east and the south-east, the coal becomes semi-anthracite and even bituminous.

The area of the anthracite field has been calculated by Richthofen at 13,500 square miles. Taking 40 feet as the average aggregate thickness of its coalseams, Richthofen arrived at a reserve of 630,000 million tons. All later authorities take Richthofen's estimate of the area as substantially correct, but consider 40 feet as the aggregate coalseam thickness to be too high.[1] Drake took 30 feet as the average workable thickness and obtained a reserve of 450,000 million tons and Inouye, assuming 15 feet, a reserve of 240,000 million tons. It is illustrative of the conservative character of the figures of the Geological Survey that it estimates the total reserve of both the bituminous and anthracite fields of South Shansi at less than 6,000 million tons.

The coalmeasures along the **foot of the Taihangshan,** where they are not defined eastwards by an outcrop of the older limestone, dip underneath the surface of the Plain at angles of about 30° in the north and perhaps rather less in the south. Their workable width is therefore limited to a few miles. There are several seams of workable thickness but the mainseam, although it may vary up to 30 feet, is usually thinner than on the plateau proper. In the northern part of this zone the coals are bituminous and coking, but in its southern part, bordering the Hwang-ho plain, anthracitic like those of the plateau. The bituminous again possess better steam-raising qualities, as measured in calories, than the anthracite coals. The Survey has estimated the reserve of the Chinghsing field, for example, within the faulted blocks of the plateau edge, at 220 million tons, and Drake, the reserve of the whole zone along

1. Shockley, for example, is of this opinion. But Bailey Willis, while agreeing that 40 feet is too high an estimate of workable thickness, considers that Richthofen underestimated the area of this anthracite coalfield.

the foot of the Taihangshan, at 7,900 million tons of bituminous and 8,000 million tons of anthracite.

The coalmeasures of the faulted blocks of West Honan along the southern edge of the Hwang-ho plain have coalseams 6 to 18 feet thick and yield anthracite coals. They are, therefore, comparable in thickness of seam and in nature of coal to those along the Taihangshan foot with which they are probably co-extensive underneath the Hwang-ho alluvium. Farther south, the **Lushan-Juchow** field, being preserved through downfaulting, is well defined. The most important seam is six to eight feet thick and produces a good quality bituminous coking coal. Drake estimates its coal reserve at 2,000 million tons and the Survey at about 350 million tons.

Iron ores occur at various horizons in the " Taiyuan " series, but chiefly at its base, throughout South Shansi in both the bituminous and anthracite fields. They take the form of nodules and concretions and not of beds of uniform thickness. Although generally under three feet thick, they may be concentrated into larger masses in the vicinity of disturbed zones. These Shansi ores are often haematites and limonites and are hence richer than the carbonate ores normally associated with the coalmeasures, but they are similarly thin and unsuited to modern mining methods. V. K. Ting has calculated their reserve at 300 million tons. There is a group of contact-metamorphic ore deposits at the very foot of the Taihangshan edge in the vicinity of Wuan, but, although their ores are of a good quality, they are all small and hardly suitable for large-scale utilization.

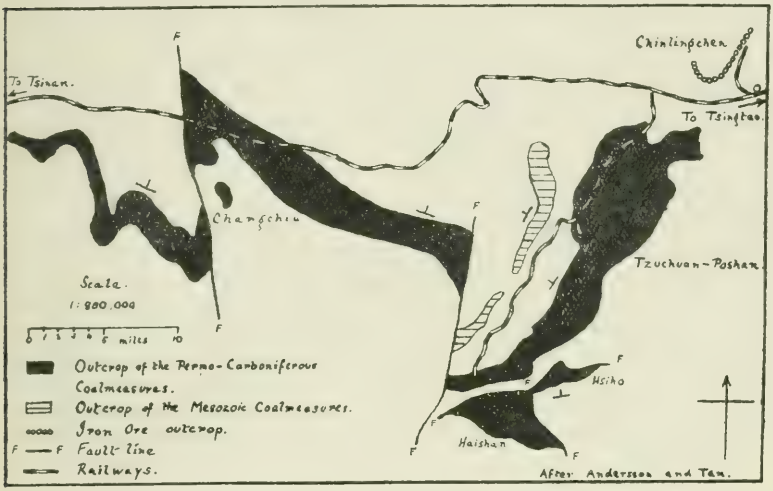
North Shantung.

The fields of North Shantung are distributed along the northern edges of the West Shantung Highlands in the valleys opening out into the Plain, and are easily accessible from the Shantung railway. The most important of these fields are Poshan, Weihsien and Changchiu.

The **Poshan** coalfield is well defined in the south but in the north, where there is an upper coalseam horizon of Lias age in addition to the main Permo-Carboniferous coalmeasures, is overlain by alluvium and may extend far out into the Plain. Throughout, there are several seams of workable thickness, whose coals are semi-bituminous in the south and semi-anthracite in the north. The coals are all low in ash and have high steam-raising qualities. The seams of the southern part, moreover, yield coking coals suitable for metallurgical use. The Survey calculates the reserve of the field at nearly 500 million tons. Drake's estimate is fully eight times this figure.

The **Changchiu** field, co-extensive with the Poshan but for a

fault scarp and itself cut up by fault lines, rests on the flanks of the highlands and pitches under the alluvium of the Plain. Although its coalseams are comparable in thickness to those of Poshan, they contain numerous partings of shale. Their coals, moreover, have a much larger proportion of ash and are non-coking. From these considerations it would appear that the Poshan field has the brighter future, although Richthofen thought otherwise.



5.—The Poshan and Changchiu Coalfields.

The margins of the **Weihsien** (or Fangtze) coalfield are overlain by volcanic tuffs and by alluvium and its extent is, therefore, undefined. Its coalseams, possibly of Lias rather than of Permo-Carboniferous age, are thicker than in the Poshan field but are more disturbed and oftener discontinuous. The coals they yield are bituminous and, despite a considerable proportion of ash, good steam-raisers.

Ferruginous shales are encountered at the base of the coal-measures as throughout North China and there are several contact metamorphic deposits developed around grano-diorite intrusions. But the only workable ore body is the **Chinlingchen** contact deposit situated close to the Shantung railway and in proximity to the Poshan coalfield. The ore appears to occur in fairly thick masses as a magnetite-haematite, normal in such a contact deposit. It has an iron content of 55 per cent., is non-phosphoric and, being calcareous, is self-fluxing. The Survey places its reserve at just under 14 million tons.

The South-Eastern Quadrant of the Plain.

The coalfields of the south-eastern quadrant of the North China Plain lie around the edges of the West Shantung Highlands and of low hills, outliers of the Highlands, isolated within the alluvium of the Hwai basin. The most important are the Ihsien, the Hsiaohsien and the Tungshan basins along the northern edge of this section of the Plain and the Hwaiyuan field near the Hwai river. All are more or less accessible from the Tientsin-Pukow railway.

The **Ihsien** field has coalseams which, varying up to 30 feet, are generally thicker than in northern Shantung. They yield a clean bituminous coking coal. Drake estimates its reserve at 1,838 million tons and Inouye at 500 million tons. Just across the Kiangsu border the Tungshan or **Chiawang** field, with a reserve according to the Survey of 144 million tons, has several seams of workable thickness and produces a bituminous coking coal. The Hwaiyuan field, with rather thicker seams but producing a similar coal, has a reserve of only 25 million tons.

Iron ores are interstratified in the coalmeasures in a manner and of a quality similar to those throughout the Permo-Carboniferous of North China. Magnetite-haematite ore bodies are developed around the contact of grano-diorite intrusions at a locality to the south of the Ihsien coalfield. They have a reserve of, at any rate, three million tons of ore, with an iron content of about 55 per cent.

THE YANGTZE VALLEY BELOW THE GORGES

The Yangtze Valley below the Gorges constitutes a well-marked natural region, intermediate in climate between North and South China and permitting the cultivation of crops characteristic of both. It consists of rich basins alternating with hilly stretches not only in the country tributary to it but also along the main Valley itself. In order to appreciate their function in industry, it is best to consider the coalfields of the Yangtze Valley in relation to the several basins of the region—the Yangtze Delta, Kiangsi, the Hupeh Basin, the upper Han Basin and the Basins of Hunan—in whose vicinity the concentration of industry is likely to take place.

The coalfields of the **Yangtze Delta,** all on its south-western margins, lie within the following synclinal troughs: the Tsientang valley of Chekiang, the Ningkwo field extending westwards from the Taihu lake and the Nanking fields paralleling the Yangtze. The Tsientang and Nanking fields are highly disturbed and their coalseams steeply inclined. They have but one or two seams of

workable thickness apiece and these yield anthracite and semi-anthracite coals generally of a poor quality. The Hwaining field to the north of Anking, though disturbed by igneous intrusions, has several seams of workable thickness and a reserve of 61 million tons. The **Ningkwo** field is much more gently folded, broadening out and sinking under the alluvium eastwards. In the more compressed western part its coals are anthracite or semi-anthracite but in the east they are predominantly bituminous. Although the coal-measures have suffered considerable erosion and only the remnants of a former great coalfield remain, it is distinctly the most important of the Delta. A couple of synclines of its eastern part have an estimated reserve of 21 million tons. The total reserve of these fields of the Delta, however, though larger than was once supposed, amounts to but a few hundred million tons.

The coalfields of **Kiangsi** lie in east-west synclinals and often represent extensions over from neighbouring basins. The fields of upper Kiangsi are all of this nature, small and high up on the watershed. The Tsientang field of Chekiang extends over into the upper Kinkiang valley of Kiangsi : its seams are similarly thin and it has no great extent. The largest, which may be termed the **Loping** field, stretches across Kiangsi south of the Poyang lake. Like the Ningkwo field, it becomes broader and its folding more gentle as it pitches under the alluvium eastwards. All, including Richthofen, recognize its importance.

The coal resources of the **Hupeh Basin** are quite small, smaller even than those of the Delta. They seem to be confined to the hilly country of the eastern and western margins, in the vicinity of Tayeh in the east and of the Gorges in the west. The coals in the east are of Permo-Carboniferous age and are bituminous. In the west the coalseams are thin, appear to be mainly of Rhaetic-Lias age and yield anthracite coals. The coalseams of the Yangtze Gorges field, though again of Rhaetic-Lias age, are thicker and yield coals which are bituminous rather than anthracite.

It is quite clear from the foregoing that the industrial importance of the Delta and of the Hupeh Basin[1] has not issued out of their local coal resources, which are only small and not as yet extensively utilized. Their industrial significance is due rather, as will appear more definitely in a later chapter, to their position each at a focus of routes and to the fertility and dense population of their plains.

The upper **Han Basin** has similarly meagre coal resources. Coalseams occur in horizons of both the great coal-forming periods.

1. The Hupeh Basin is in the very heart of China—where N-S routes, linking North China with South China, cross the E-W Yangtze route—and is on that account becoming known as the Central Basin.

They have, however, been intensely folded and have undergone considerable metamorphism, so that they are badly squeezed, discontinuous and often vertical and yield coals generally of a poor quality.

The most important coalfields of the whole of the Lower Yangtze Valley are unquestionably those of the Siang river basin in **Eastern Hunan.** There are coalmeasures of both Permian and Rhaetic age, the Permian stretching the length of the Siang valley, but the Rhaetic being confined to a zone up on the Kan-Siang watershed.

In the main Siang valley the Permian coalmeasures are overlain by Triassic and Tertiary sandstones often to a depth of several thousand feet. The thickness of this cover decreases, however, upstream so that the more important coalfields lie along the upper Siang valley and especially along the valley of its tributary, the Lei. This **Leiyang** field has several seams well over three feet thick, which yield a good quality anthracite low in ash. The fields of the upper Siang valley have seams of similar thickness, but yield a bituminous rather than an anthracite coal.

The Rhaetic coalmeasures of the **Pinghsiang**[1] basin up on the Kan-Siang watershed have suffered considerable disturbance. The thinner seams, under two feet thick, yield the best lump, a semi-bituminous coal fairly low in ash. The thicker seams, varying up to 36 feet, produce soft coals, mostly slack and high in ash. But this soft slack coal produces a good coke, low in phosphorus and sulphur, and eminently suitable for blast furnace practice.

To the west of the Siang, coalmeasures occur in sandstones of early Carboniferous age in the upper Tzu basin and along the middle course of the Yuan. The thickest seam is on the average three feet, and is comparable to that of the possibly contemporaneous Carboniferous coalmeasures of Yunnan.

Whatever their actual estimates of reserve may be, all authorities agree that these Hunan fields together constitute one of the most important coalfield groups in China after that of Shansi. The Survey attributes to Hunan an anthracite reserve of 1,000 million tons distributed between the Leiyang and the middle Siang fields and a bituminous reserve of 600 million tons distributed in smaller units among the Permian upper Siang fields, the Rhaetic fields along the Kiangsi border and the Carboniferous fields of west and central Hunan. The Pinghsiang field, with a reserve of several hundred million tons,[2] being in Kiangsi, is not included in these

1. Pinghsiang is actually within Kiangsi province but its relations are all with Hunan.

2. According to Drake, Inouye and the Hanyehping Company, which works the field.

estimates. The corresponding estimates of Drake, again exclusive of Pinghsiang, are 48,000 million tons of anthracite and 42,000 million tons of bituminous.

The Permian coalmeasures of Central China, like the Permo-Carboniferous of North China, often contain an iron ore bed near their base, but it is usually thin and its ores of low grade. In the vicinity of the Pinghsiang coalfield a ferruginous sandstone, probably of Carboniferous age, is concentrated at several points through metamorphism into ore beds several feet thick but the concentrations are discontinuous and the deposits do not appear to have any economic value. Iron ore nodules and beds, conceivably of the same horizons, occur elsewhere in Hunan at any rate.

The most important iron ore bodies of the region lie along the line of the Yangtze itself in its course between the Hupeh Basin and the Delta. They are located around the contact of granodiorite intrusive into pre-existing limestones and sandstones. These ore bodies are usually of magnetite-haematite with an iron content round about 60 per cent. The best known of them is **Tayeh** at the western end of the zone. The Survey calculates that it has resources of over 32 million tons adapted to the open cut mining methods at present practised.[1] The potential reserve would be somewhat greater. Two other similar ore bodies in the vicinity of Tayeh have a combined reserve of 24 million tons. Farther downstream near the Poyang lake, the Chengmenshan ore body has a reserve of over nine million tons but the ore has an iron content of only 40 per cent. In the middle of the zone, in **Anhwei,** the sedimentary rock encasing the ores is a sandstone rather than a limestone and the ore deposits are much thinner. Fully five ore bodies of sufficient size to render them utilizable are known, but none have over ten million tons of ore adapted to modern mining methods. Their aggregate reserve of this nature amounts to less than 25 million tons. Around the bend of the Yangtze at Nanking there are several contact ore bodies but they all appear to be too small for utilization. A similarly small occurrence has been encountered just to the south of the Taihu lake.

Of all the iron ore fields of China this along the Yangtze has the richest ores and is the most accessible. But its reserve is small, being estimated by the Survey at but 90 million tons. The Archaean ores of South Manchuria, according to the same authority, have the infinitely larger reserve of 740 million tons, but they are predominantly of low grade and are workable only if they can be cheaply concentrated. The Pre-Cambrian ore field of the Peking Grid, although about the same size as the Yangtze field, having an

1. According to Tegengren's figures, 8·5 million tons of the total reserve of 32·6 million tons had already been removed by 1921.

estimated reserve of 92 million tons, has ores of somewhat poorer quality. Finally, the coalmeasure ores, though their total reserve must be far in excess of even that of the Archaean ores, occur under conditions quite unsuited to modern mining methods.

The Survey estimates the known iron ore reserve of the whole of China at some 950 million tons[1] and Tegengren, at any rate, holds out no extravagant hopes for any great increase in this total by future discoveries. This estimate concerns only those deposits which occur under conditions adapted to mining by present-day large-scale methods and the coalmeasure ores are excluded from it. The total iron ore resources of the world, so far as they are at present known, amount to 22,000 million tons according to the enquiry made for the International Geological Congress of 1910, or to 31,000 million tons according to F. A. Hatch. The officials of the Survey conclude, therefore, that the iron ore resources of China are very meagre in proportion to those of the world as a whole and that a careful policy towards their utilization must be pursued.

SOUTH CHINA

South China is distinct from the North and Centre as a physical and as a human region. It comprises not only the basin of the Sikiang but also a series of smaller basins, each having a more or less independent economic life, stretching northwards along the coast well into Chekiang.

The coastal provinces, Kwangtung, Fukien and Chekiang, lie within the old core whose coalfields are all restricted to synclinal troughs isolated within the general mass of older rocks. Coalfields of this nature seem to be the more numerous in Fukien. The most important of those of Fukien, are the Anki field nearest the coast, the Lungyen field farther inland and a series of fields along the foot of the mountain system of the Kiangsi border. The **Anki** field has seams well over three feet in thickness and possesses the only bituminous coals of Fukien. The **Lungyen** field has rather thicker seams and an estimated reserve, according to Inouye, of 80 million tons. Both the Lungyen field and the fields at the foot of the Kiangsi border produce a good quality anthracite, low in ash but often sulphurous. The most important field in Kwangtung is around **Shaochow,** in the upper basin of the Peikiang and overlooked by the Nanling range. Its seams vary in thickness up to 20 feet and its coals are bituminous, coking and of good quality. There is a smaller field, the **Maoshan,** with thinner seams in the immediate vicinity of Canton. Drake estimates the

1 Of this total, 300 million tons are termed actual resources and 1,5 million tons potential resources.

reserve of the Shaochow field at 698, and of the Maoshan at 189 million tons.

Kwangsi is structurally quite different, consisting in the main not of rugged highlands but of extensive plateaux. In the east, bordering on the old core, coalseams are interstratified in a sandstone series immediately underlying the massive Permo-Carboniferous limestone. Their coals are bituminous. Farther west, approaching the High Plateaux of Kweichow and Yunnan, the coalmeasures are of Rhaetic age. Both the Carboniferous and the Rhaetic coals are friable, but this may be characteristic only of the weathered outcrop.

The estimates of the coal reserves of South China are no more than tentative, but it is certain that its coal resources are not in magnitude comparable to those of any of the neighbouring regions of China. The estimates of the reserve of Fukien are all surprisingly small. Drake estimates the reserve of the old core as greater than that of Kwangsi. The later estimate of the Survey makes them more nearly comparable.

Iron ores are frequently encountered throughout the old core but are rarer on the plateau of Kwangsi. Only in a few cases are their nature and potentialities known. Iron ore beds are interstratified in the Permo-Carboniferous coalmeasures and ore nodules are scattered through the Mesozoic sandstones. Magnetite grains are common in alluvial deposits along the Fukien and Chekiang rivers. There are a couple of ore bodies developed along the contact with intrusive rocks and one of them, Anki, is the most important yet known in South China. The reserve of this magnetite mass has been variously estimated at 10 and 2·5 million tons. The Survey estimates the total iron ore reserve of Fukien at only 7·5 million tons.

THE BASIN OF SZECHUAN

The Basin of Szechuan, isolated in the far west, is a natural unit which requires no emphasis. Its coalmeasures, of Rhaetic-Lias age, rise along the northern rim of the Basin from beneath the plateau of Cretaceous red sandstones covering its centre, and crop out in the south along the crests and the hillsides of denuded anticlines. The coals along the northern rim are bituminous and are of a better quality than the coals, often anthracitic, of the south. But they are all friable and high in ash and are generally acknowledged to be of poorer quality than coals of a similar age elsewhere in China.

The estimates of the coal reserve of Szechuan, as it is so little known, necessarily vary widely. The Survey estimate of 1,500 million tons may be taken to represent the actual known reserve

exclusive of any hypothetical extensions under younger strata. Drake's estimate of 80,000 million tons would represent the potential reserve.

Thin beds of carbonate iron ores containing no more than 35 to 40 per cent. of iron, are throughout interstratified in the Rhaetic-Lias coalmeasures. Haematite ores, representing local concretions into nodules scattered irregularly throughout the parent rock, occur in Triassic red sandstones along either side of the Kweichow border. Neither class of ore appears to be suited to any large-scale utilization.

THE HIGH SOUTH-WESTERN PLATEAUX

The structural differences between the Mountain System of the Far West and the western margins of the South China Plateaux have an extremely important bearing on the character of the coal-measures, but they have not a corresponding influence on the surface relief. The High South-Western Plateaux, Yunnan and Kweichow, comprise, therefore, parts of both structural elements. As a region, it is the least penetrated by Chinese culture, is peopled largely by a pre-Chinese stock and was only late brought within the political control of China. It is not, therefore, characteristically Chinese.

The productive coalmeasures are confined to the Permo-Carboniferous and the Rhaetic, although coalseams are known at several geological horizons between them. Save in the north, the thickest coalseam in the Carboniferous of eastern Yunnan rarely swells to over three feet. Its coals are semi-bituminous and, though good steam-raisers, have a high ash content. The main coal-bearing horizon farther east is the Rhaetic. Along the contact between the two structural elements the Rhaetic coalmeasures are intensely folded but eastwards they dip but gently in harmony with the general easterly tilt of the Kweichow plateau. These Rhaetic seams are thicker than the Carboniferous and yield bituminous coals of better quality. The coals throughout are friable and produce a big proportion of slack, but this again may be confined to the weathered outcrop. Both the Carboniferous and the Rhaetic coals yield coke, but only from the former is it sufficiently strong for blast furnace practice.

The coal resources of the High Plateaux are undoubtedly of considerable magnitude. Leclère estimates the total reserve at 30,000 million tons, distributed in equal proportions between the semi-bituminous Carboniferous field, the bituminous field of the contact zone and the coalfield of West Kweichow. Drake's corresponding estimate is 60,000 million tons and the Survey's 2,500 million tons.

Iron ores are widely distributed throughout the region. They are mainly sedimentary in Yunnan, interstratified in thin beds in Devonian clay slates, in metamorphosed Palaeozoic limestones and in the Rhaetic coalmeasures. Some of the iron ore bodies scattered throughout Kweichow appear to be replacement deposits in limestone whose ores are similar to those of the replacement ore bodies of Bilbao in northern Spain. It, therefore, appears probable that the most important iron ore bodies lie away to the east of the coking coals of East Yunnan.

In the table which follows, the character of the coal is indicated by symbol, A denoting anthracite, B bituminous, and C subbituminous. The addition of an asterisk signifies that it yields a good metallurgical coke. It must be understood that all coking coals are not suited for metallurgical use. The estimates of coal reserves are not strictly comparable as they stand. Those made by Drake and Inouye are of probable reserves. For those fields for which they venture an estimate of actual reserve, that figure is given in brackets. The estimates of the Geological Survey (G.S.) all refer to actual reserves. Where the Survey estimates can be traced to individual geologists they are extracted from the various numbers of the Bulletin of the Geological Survey: the other figures of the Survey are given by its Director, W. H. Wong, in the 1923 issue of the China Year Book.

THE COAL RESOURCES OF CHINA.

Field.	Coal.	Reserve in M.T.	Authority.
SOUTH MANCHURIA—			
Penchihu	B *	180 (16)	... Inouye.
Yentai	A	25 (15)	... Inouye.
Do.	A	20	... S.M.R.
Fushun	B *	498 (378)	... Inouye.
Do.	B *	999	... S.M.R.
Peipiao (Chihli)	B	220 (164)	... Drake.
Nanpiao (Chihli)	A	200 (150)	... Drake.
Do.	B	200 (150)	... Drake.
NORTH CHINA—			
Shihmenchai	A	200 ...	... Inouye.
Do.	A	100 ...	... Yih and Liu (G.S.).
Lingshan	A	30 ...	... Li (G.S.).
Fangshan-Wangping ...	A	7,460 (5,577)	... Drake.
Do.	B	660 (386)	... Drake.
Kaiping	B *	2,757 (1,641)	... Drake.
Do.	B *	400	... Inouye.
Tatung	B	1,354	... Wang (G.S.).
Do.	B	8,200 (3,060)	... Drake.
Do.	—	1,200	... Inouye.
Yuhsien-Sininghsien ...	B	438	... Ting and Chang (G.S.).
Hun-ho fields	A	160 (132)	... Drake.
Do.	B	90 (57)	... Drake.

Field.	Coal.	Reserve in M.T.	Authority.
NORTH CHINA—continued.			
North Shensi	B	1,000 ...	Drake.
Do.	B	under 1,000 ...	G.S.
Shansi anthracite field ...	A	630,000 ...	Richthofen.
Do.	A	300,000 (240,000)	Drake.
Do.	B	150,000 (120,000)	Drake.
Do.	A	240,000 ...	Inouye.
Shansi bituminous field ...	B	255,890 ...	Drake.
Taihangshan foot ...	A	7,900 (851) ...	Drake.
Do.	B *	8,000 (3,763)...	Drake.
Chinghsing	B	120	Inouye.
Do.	B	220	Chu and Li (G.S.).
Lincheng	B	100	Inouye.
All Shansi (inc. Tatung)...	A	2,370	G.S.
Do.	B	3,460	G.S.
Honanfu	A	175	Drake.
Lushan-Juchow	B	under 380 ...	G.S.
Do.	B	2,000	Drake.
Poshan (Tzuchuan) ...	B *	497	Tan (G.S.).
Do.	A	2,000 (1,360)...	Drake.
Do.	B	2,000 (1,360)...	Drake.
Weihsien (Fangtze) ...	B	245 (202) ...	Drake.
Do. ...	B	100	Inouye.
Ihsien	B *	500	Inouye.
Do.	B *	1,838 (1,280)...	Drake.
Tungshan (Chiawang) ...	B	144	Liu and Chao (G.S.).
Hsiaohsien	B	31	Liu and Chao (G.S.).
Hwaiyuan	B	25	Liu and Chao (G.S.).
	B	54	Wang (G.S.).
YANGTZE VALLEY—			
Ningkwo field (part only)	A	187	Drake.
Do.	B	21	Yih (G.S.).
Hwaining	—	61	Liu and Chao (G.S.).
Loping (part only) ...	—	25	Drake.
Do.	—	400	Inouye.
Pinghsiang	B *	350 (325) ...	Drake.
Do.	B *	300	Inouye.
All Kiangsi	A	110	G.S.
(inc. Pinghsiang).	B	705	G.S.
Leiyang	A	48,000	Drake.
Siang field	B	41,500	Drake.
All Hunan	—	17,000	Inouye.
Do.	A	1,000	G.S.
Do.	B	600	G.S.
Yangtze Gorges	B	50	Hsieh and Chao (G.S.)
SOUTH CHINA—			
Lungyen	A	80	Inouye.
All Fukien	A	150	G.S.
Do.	A	25	Drake.
Shaochow	B	968 (408) ...	Drake.
Maoshan	—	189	Drake.
All Kwangtung		1,009	Drake.
Do.	A	200	G.S.
Do.	B	100	G.S.
All Kwangsi		500	Drake.
Do.	B	500	G.S.

Field.	Coal.	Reserve in M.T.	Authority.
Basin of Szechuan ...	A	200 ...	... G.S.
Do.	B	1,300 ...	... G.S.
Do.	—	15,000 ...	... Inouye.
Do.	A	20,000 ...	... Drake.
Do.	B	60,000 ...	... Drake.
Do.	C	500 ...	... Drake.
Kweichow and Yunnan—			
All Kweichow	B	1,300 ...	... G.S.
Do.	B	30,000 ...	... Drake.
All Yunnan	B	1,200 ...	... G.S.
Do.	B	30,000 ...	... Drake.
Do.	C	100 ...	... Drake.
Kweichow-Yunnan ...	B	30,000 ...	... Leclère.

Chapter III

THE HISTORICAL GEOGRAPHY AND THE FACTORS AFFECTING THE FUTURE OF THE COAL AND IRON INDUSTRIES OF CHINA

A curious combination of circumstances led to a very early utilization of coal in the North-West of China, the homeland of Chinese civilization. Its cold winters necessitated fires for warmth as well as for cooking and, although the country was loess-covered and comparatively treeless, coal resources were abundant and easily accessible. The earliest reference to coal in Chinese literature dates back to the period of the Han dynasty, about the beginning of the present era, but from the above considerations it is probable that it was known and utilized still earlier.

So long as China remained essentially unchanged by any contact with the West, certain controlling factors dominated the coal industry. They still operate in West and in much of South China. Old-time Chinese methods of mine drainage were quite inadequate and are reminiscent of attempts to deal with a similar problem in mediaeval England. Mining, in consequence, ceased whenever the water-table was pierced. Coal production during this period was destined mainly for domestic and not for industrial consumption and for household use the Chinese preferred, and still prefer, anthracite on account of its comparative freedom from smoke. Where anthracite was inaccessible, coke was preferred to bituminous coal again partly because of its comparative smokelessness and partly because, having a more concentrated fuel value, it better repaid the high cost of transportation. The enormous cost of transport by coolie, wheelbarrow and pack-animal limited the coal market to within a very definite radius around the mine. The division into isolated self-sufficient units was hence in this period at its maximum.

The coalfields peripheral to the North China Plain and to the lowlands of South Manchuria served in this period similar functions, feeding, as well as a local market, the adjacent parts of the Plain. The peculiar conditions which now differentiate South Manchuria from North China in the trend of its economic development had not then arisen.

The eastern margins of the Plain exhibited similar features and were somewhat inter-related. The more important coalfields

almost monopolised the market, the Poshan field, for example, that of Northern Shantung and the Penchihu field, that of the plains of East Manchuria. A favourably situated field such as Wonhoshui on the very tip of the Liautung peninsula, although its coals are poor and itself small, could develop an important coal export around the coasts of Liautung and even across to the northern shore of East Shantung. The fields actually within the highland massif of Liautung served more than a local market only because of iron ore masses in their vicinity and because of their coking coals. There was, too, a considerable development of industry on the Poshan coalfield, based on its pottery clays and glass sands.

The coalfields along the western margins of the Plain produced anthracite rather than bituminous coal and were hence especially fitted to serve a wide domestic market. The anthracite of the Shihmenchai field, the best east of Peking, was then of much greater importance than the bituminous coal of Kaiping. The coal market south of Peking was supplied by the Fangshan-Wangping field, by the Shansi field especially from around Pingting and from the fields overlooking the Hwang-ho plain. From each of these an extensive coal trade was developed. The trade in coal over the Taihangshan edge from Pingting, for example, was calculated by Shockley to reach 30-40,000 tons per year.[1]

No such important trade seems to have developed in that section of the Plain to the south of the old course of Hwang-ho. The peripheral coalfields yielded bituminous rather than anthracite coals and the trade from them was, in consequence, rather restricted. Throughout the centre of the Plain, as in this southern region, the mass of the population was too poor to afford the expensive coal transported from the margins and had to be content with dried grass and dried roots. The factors limiting the coal market were, therefore, essentially the high cost of transportation and the low standard of living.

Coal was mined all over South Shansi for local consumption and as the fields are so extensive and so easy to work no internal coal trade developed. It was otherwise with its margins, bordering on fertile plains and basins devoid of coal resources. There was not only a movement of coal down into the North China Plain but also from the lower Fen-ho fields in the west into the Wei-ho valley. The coal resources of the huge basin of North Shensi were utilized at only a few points and then only for a very restricted local market. Even in the bituminous fields of West Shansi the thinner anthracite seams were mined in preference to the thicker bituminous seams.

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1. W. H. Shockley. "Notes on the Coal and Iron Fields of South-eastern Shansi." *Trans. Amer. Inst. Min Engin.*, Vol. 43, p. 848.

Most of the scattered coalfields of the Peking Grid were worked for local domestic consumption but only the better coals were transported any distance away from the mine. Kalgan, for example, preferred the better quality coals from Yuhsien and Tatung, although they had to be transported over longer distances, to the poorer quality coals around Hsuanhwa comparatively nearby.

In this period a considerable coal trade had developed along the Yangtze Valley. The Ningkwo and Nanking coalfields were worked only to a limited extent and were unable to supply the whole of the coal market around the Yangtze Delta. In consequence an important trade sprang up along the Yangtze in Hunan anthracite, apparently from the Leiyang field. Such long distance traffic was made possible only by the relative cheapness of transport along the arterial waterway of the Yangtze. The Hupeh Basin, like the Delta, was dependent for the bulk of its coal supplies on the Hunan fields.

Elsewhere in South China the coal market was confined to the immediate vicinity of the coalfields. Domestic fuel requirements were limited and an alternative fuel still remained on the forested slopes of the hills. On the High Plateaux and in the Basin of Szechuan, coalfields are sufficiently widely distributed as to preclude the development of a coal trade of any magnitude.

Iron was introduced into China at any rate as early as the eighth century B.C., but did not finally replace bronze until fully five centures later.[1] The earliest iron smelting seems to have been in the loess country of North-West China, but by the time of the Han dynasty iron smelting was widespread and utilized the contact-metamorphic ore bodies of North China and the Yangtze Valley as well as coalmeasure ores of the Shansi type.

Iron smelting by old-time Chinese methods was essentially a small-scale and almost a part-time industry and could be prosecuted on the basis of even such small deposits as magnetite grains in river alluvium. Small iron deposits are scattered throughout China and the location of iron smelting, as iron was accessible almost everywhere, was determined therefore by the supply of fuel.[2] Charcoal long remained the only fuel employed and the impetus to the substitution of coal or coke came, as the world over, through the disappearance of woodland. The use of charcoal still persists in those districts of West and South China where sufficient woodland still lingers. With the disappearance of woodland in North China, iron smelting became concentrated on the coalfields, the more so

1. On the evidence in ancient Chinese literature, H. T. Chang. "Lapidarium Sinicum." *Mem. Geol. Surv. China.*

2. The Chinese charcoal iron industry offers several points of comparison with the English charcoal iron industry. The location of both, for example, was determined by the fuel rather than by the ore supply and both declined with the gradual disappearance of woodland.

because of its huge coal consumption, and especially on to the " Anthracit-Terrasse " of Shansi, where a particular process of smelting, using anthracite as a fuel, was evolved. Only then, from perhaps the twelfth century onwards, did the Shansi iron industry begin to acquire its fame and predominance.

Chinese iron smelting has always been directed towards the production of iron suitable for casting rather than, as in Europe prior to the modern period, of malleable iron. Extraordinarily thin castings were made possible by reason of the high phosphorus content of many Chinese coals, particularly Shansi anthracite. But high-phosphorus iron is unsuitable for most purposes apart from the production of thin castings and native Chinese iron still retains some proportion of slag and ash. Foreign iron can, therefore, easily compete with it in the general market.

In the later centuries the most important iron industry of China was centred on the " Anthracit-Terrasse " of Shansi. There were apparently several centres of this industry where pig-irons brought in from surrounding tributary villages were worked up into manufactured iron. In this there was considerable specialization so that one village made scissors, another shovels and a third needles. The Shansi industry dominated the manufactured iron market of the whole of North China, which had only one other iron industry, on the coalfields of Liautung, of any importance. In South China the iron market was supplied from several centres, each serving a well-defined region, rather than from a single centre as in North China. Such essentially domestic ware as iron pans and kettles here formed almost the only manufactured iron goods in demand. Throughout China, agricultural implements seem to have been manufactured by local forges using pig-irons from the iron smelting centres. This is characteristic of self-sufficient rural economy the world over.

The transformation of the coal and iron industries of China through contact with the West began with the introduction of the steamer. Long before 1870 steamer traffic had developed on the Yangtze between Hankow and Shanghai and had increased the volume of the trade in Hunan anthracite which, though not entirely suitable for boiler consumption, was the best available along the Yangtze Valley. But mining methods remained unchanged and the coal market continued to be supplied by small mines. The increasing use of the steamer, consuming larger quantities of coal than small mines could supply, led ultimately, however, to large-scale coal production. Although foreign vessels could coal away from the Far East, Chinese coasting steamers were dependent on supplies of coal within China itself. The demand of the China Merchants' Steam Navigation Company brought about the introduc-

tion of large-scale mining in 1878 on the Kaiping coalfield, significantly near the shoreline and adapted, therefore, to supply steamer traffic. The initiative in this, the first large-scale mining enterprise in China, was essentially Chinese.

A long period then elapsed before any further attempt was made at large-scale coalmining in China. The Manchu opposition to the introduction of western methods crippled the development of the Kaiping coalmine. The market for coal on a large scale was, moreover, as yet confined to the steamer.

With the introduction of vast schemes of railway construction after 1895, conditions were quite different. The construction of the great trunk railway lines, themselves witnesses of the changed government attitude[1] and of the political pressure of foreign powers, created a demand within China itself for coal on a large scale. Henceforward large-scale coalmining bears an intimate relationship to railway development, which served and continues to serve both as a consumer and as a distributer of coal production. It was no longer confined to a mere coastal strip. As time went on the coal market served by large-scale mines gradually extended to include the industrial market, largely a new creation since the transformation of industry from its domestic phase, and the domestic market, hitherto supplied entirely from small mines. In consequence, small coalmines worked by old-time methods, around the North China Plain at any rate, have now but a fraction of the importance they once possessed.

These railway lines, from the point of view of their ownership, fall into two main classes: those under foreign ownership and those forming part of the Chinese Government railway system. Each class has quite distinct characteristics. The foreign lines penetrate into China from the outside: from Siberia and Korea into Manchuria, from Tongking into Yunnan and from the base of Tsingtao into Shantung.[2] In strong contrast, the Chinese Government lines, though linked on to all these systems save that of Tongking, radiate out from the capital, Peking.

In Shantung and Manchuria, foreigners have had the right to exclusive mining rights within a certain zone on either side of the railway track and coalmines worked under such conditions have suffered no competition. Foreign coalmining enterprise elsewhere has had no such exclusive rights and in the case of the more important concerns rival Chinese companies were set up in opposition on the same coalfield. It is significant of the change of attitude

1. Before this date, in 1891, the Chinese government had, however, begun the construction of the Peking-Mukden line.

2. The Shantung railway is now a part of the Chinese Government railway system, being handed over as from Jan. 1, 1923.

on both sides that the foreign concerns and the opposition Chinese concerns have subsequently found it in their interest to amalgamate.[1]

In the iron industry, as in the coal industry, the first effect of the contact with the West did not lead directly to any change in method. Old iron of foreign origin, particularly old horseshoes, was imported increasingly into the coastal provinces and was consumed by local forges for the manufacture of agricultural implements. This old iron import affected the long-established iron industries only by undermining their pig-iron market in the local forges, leaving the market for domestic ironware untouched. The movement was felt on the coast in the time of Richthofen, but its effect on Shansi did not become marked until about 1888, subsequent to which date the Shansi iron industry rapidly declined from an annual pig-iron production of 160,000 tons to one of but 50,000 tons at the beginning of the twentieth century.[2] At the present time the market for the old-time iron industry is, in North China, strictly limited to the demand for domestic utensils for which it supplies iron more suitable than foreign or blast furnace iron. The effect of foreign iron on the iron market of South China seems to have been much less prominent and the old-time iron industries continue to flourish.

The first attempt to set up an iron industry on western lines in China was, like the Kaiping coalmine, a purely Chinese venture. Although merely fortuitous circumstances[3] brought about its location at Hanyang in the Yangtze Valley, it was set up near one of the richest iron fields of China. Later erections of modern iron and steel plant have been located in the North, in South Manchuria and Shantung, and, being in intimate relationship to the needs of the iron industry of Japan, have been under part Japanese ownership. The latest projects, put forward by the Lungyen and Kailan companies of the Peking Basin, for the establishment of an iron industry are, however, independent of Japanese influence.

1. The two most important of such amalgamated companies are the Kailan Mining Administration, working the Kaiping field, and the Fuchung Corporation, working an anthracite field at the foot of the Taihangshan. The former was constituted in 1912 out of the Chinese Engineering and Mining Company, a British concern, and the Lanchow Mining Company, the Chinese concern. The latter was formed in 1915 out of the Pekin Syndicate, a British Company, and the Chinese Chungyuan Company.

2. W. H. Shockley, *op. cit.*, p. 870-71.

3. The provincial viceroy of Canton, Chang, conceived the plan of an ironworks to supply Chinese railway construction then just beginning. The ironworks was ordered for Canton but meanwhile Chang had been removed to Wuchang in the Central Basin and the government ironworks was erected across the river at Hanyang. The location of the raw materials was not, in the first instance, considered at all.

THE FACTORS AFFECTING THE FUTURE

There are no indications in China of a revolt against modern industrialism as such and in this respect China offers a striking contrast to India. The adoption of western mining and industrial methods will hence proceed in those regions where economic and geographical factors are favourable and under conditions determined by government regulation.

The most obvious and perhaps the most important hindrance to the general economic development of China is the character of the transportation system. Apart from the navigable rivers and the few railways, transport is exceedingly expensive, cumbersome and slow. These difficulties reach their maximum power of obstruction in the utilization of such bulky commodities as coal and iron.

Waterways have always formed the traditional means of communication in China but of all the great rivers the Yangtze and the Sikiang alone are adapted to traffic on a large scale. Only short stretches of other rivers, such as the Hwang-ho, are navigable at all. The river courses across the North China Plain are too shallow for navigation save where artificially canalized. Canal construction is easy in the various river deltas and in the North China Plain but, while the short local canals still support an intense volume of traffic, the long-distance canals have fallen into disrepair. Waterway transport is cheaper than railway transport would be, therefore, only along the Yangtze and the Sikiang for long-distance traffic and for local traffic only, in addition to the above, in the deltas and lower courses of certain rivers. Elsewhere in China railways supply the cheapest and most efficient transportation, especially for long distances.

The present railway system of China, however, consisting in the main of north-south lines, does not compete directly except in a few localities[1] with the great east-west arterial waterways. These waterways lie in South and Central China, where railway construction has not proceeded far, while the railway system is as yet almost confined to North China, devoid of navigable waterways. The transport agent even on the waterways, however, is changing, for the steamer and the steam launch are rapidly replacing the native Chinese junk.

It is significant that every large-scale coalmining enterprise in China is intimately related to existing railway communications and it follows that they are restricted with a single exception to North China. The coal resources of the Yangtze lie away back

1. The most important example is the Shanghai-Nanking railway of the Yangtze Delta

from the arterial waterway, and of the Sikiang are isolated in its upper reaches, so that the future development of the coal resources of the South and Centre, as well as of the North, largely depends on and awaits railway construction.

The stability of the coal and iron industries depends on the security of their markets. There is no evidence in China, as there is in Japan, of an excess of coal output over consumption, so that the position of coalmining is essentially stable. The industrialization of China, whose ultimate arrival admits of no doubt, and a more complex system of transport on which it depends will not only create a greater coal market in themselves but will, by an increase in the volume of international trade and by a raising of the standard of comfort, increase the consumption of coal for ships' bunkers and for domestic purposes. The potential coal market in China is hence enormous. Oil and hydro-electric power will probably in the future infringe the monoply now enjoyed by coal, but whether they can entirely replace coal, especially in a country like China, with ample coal resources, is a matter as yet of speculation. It is, however, certain that the coal industry of China will not advance beyond the capacity of its markets, for the general conditions hampering the growth of industrialism restrict mining development to an even greater degree.

The first attempts of China to establish a cotton industry along western lines were unsuccessful, but its later development has disproved its earlier experience. The failure as yet of China to produce iron and steel at prices comparable to those of the West is a result of inexperience which, in a highly technical industry, will take long to remove. Although competition with imported iron and steel may now be difficult or even impossible in times of low prices, the ultimate future of the iron and steel industry in China is not open to question. The raw materials all lie within the country and the natural difficulties of assembling them are no greater than in the other regions of great iron and steel production elsewhere. The demand for iron goods in the old China was extraordinarily restricted, but with industrialization the market for iron and steel goods, still confined, will expand enormously.

The human conditions affecting the rate of the acceptance of western mining methods have often been stressed and generally without much sympathy. It is not to be expected that a people of an ancient civilization will adopt immediately and in its entirety the economic organization of an alien society. The transformation of an ancient society to meet the requirements of the new social environment of factory industrialism must, of necessity, be a long and involved process. It is, however, now evident that the general economic principles underlying industrial enterprise are becoming appreciated by Chinese industrialists. Of this, the analysis by

Lieu, of the accounts of the Hanyang iron and steel works, is a clear witness.[1]

The large-scale utilization of coal and iron, in the immediate future at any rate, is likely to be organised in the main along two lines, by the joint-stock company and by the State. As in the past Chinese commercial activity has been mercantile rather than industrial, the Chinese have experienced considerable difficulty in adapting themselves to the new organization of the joint-stock company. Individual directors, for example, often show no sense of responsibility to the company as a corporate body, but this is gradually disappearing. The success of such purely Chinese concerns as the Chunghsing coalmining company of southern Shantung is indicative of the future of the joint-stock company in China.

The question of State ownership of mining enterprise in China is a more difficult problem. At present only three coal mines of any importance are owned by the State, and by the provincial rather than by the central government.[2] The 1914 Regulations concerning ironmining in China have often been held to imply State ownership, but they merely exercise especially strict supervision over the iron ore fields to prevent them from being held for speculation and from falling into the hands of foreign interests. Among the Chinese there is unquestionably a distrust of the central government, the organization of mining by which is, therefore, quite improbable. But the provincial governments, being less remote and having a somewhat closer relationship to the village society, have not earned the same distrust and they have set up a number of industrial enterprises of various kinds. They may hence play some part in the organization of the coal and iron industries of the future.

In whatever way mining is organized in the future, the question of the origin of the capital to prosecute it arises. In the past Chinese capital has been invested only very sparingly in mining enterprises and existing mining companies have been in consequence largely dependent on foreign bankers. It has hence been generally assumed that foreign capital is essential to the development of the coal and iron resources of China. But the small Chinese investment of the past has been due to distrust of company administration and not to the absence of capital available for investment. Whenever its administration becomes honest and confidence in it established, the joint-stock company is, therefore, likely to be financed solely by Chinese capital. The modern Chinese bank, moreover,

1. D. K. Lieu, "Cost of iron and steel production in China." *Far Eastern Review*, 1921.

2. The Tan-hanwan mine of Hupeh, the Chimingshan mine of the Peking Grid and the Yukan mine of Kiangsi.

is no longer a mere exchange shop, as in the past, but discharges the functions, such as the financing of industrial enterprises, of a European or American bank.[1] Through such banks, capital otherwise inaccessible will become available for mining development. And finally, capital will accumulate as industrialization proceeds. From these considerations it appears probable that the dependence on foreign capital will gradually, given stable political conditions perhaps quickly, disappear.

In the immediate future, however, all recognize that foreign capital is necessary for mining development, but opinion is divided as to the terms on which it should be admitted. Foreign interests demand its free admission on equal terms with Chinese capital. The Chinese Government Mining Regulations, on the other hand, restrict foreign shareholders to one-half of the total capitalization.

Arguing for the free admission of foreign capital, W. F. Collins[2] states it is his opinion that China has failed adequately to develop her mineral wealth and that foreigners in need of Chinese coal and iron cannot be expected to leave them unutilized. He, therefore, concludes that foreign capital will be invested in mining in any case, if not under Chinese law, then in defiance of it, as has already happened in Manchuria. But a rapid development of Chinese mineral wealth is not to be desired and Chinese mining enterprise does even now satisfy in some measure the needs of the foreigner, represented, of course, in the case of coal and iron, chiefly by Japan. Moreover, Japanese territorial aggression in Manchuria cannot be interpreted as being due simply to her needs of Manchurian coal and iron undeveloped by the Chinese.

The other side of the question is put forward by V. K. Ting,[3] for example. The advocates of the unfettered introduction of foreign capital maintain that China nurses an unjustifiable distrust of foreigners, but Ting, on the other hand, regards the real Chinese objection to the introduction of foreign capital to be the rights of extraterritoriality, which themselves witness to a distrust of Chinese law. He, therefore, maintains that whenever extraterritorial privileges are surrendered and the foreigner made subject to Chinese law, foreign capital can be freely admitted on equal terms with Chinese. But the surrender of the rights of extraterritoriality itself depends on the establishment of a revised judicial system on such a basis as to afford reasonable guarantees to foreign traders

1. The Chinese Bankers' Association, comprising most of the purely Chinese banks of the modern type, has a membership of thirty-two and is becoming an important banking corporation. See the list of members in *China Year Book*, 1923.

2. W. F. Collins. *Mineral Enterprise in China.*

3. V. K. Ting. "Mining Legislation and Development in China." Appendix II of Collins' *Mineral Enterprise in China.*

and residents in China. The whole question is under discussion at the time of writing.

The introduction of large-scale mining methods has necessitated the drawing up of new regulations to meet them. The latest were issued in 1914. Foreign interests have accused these mining regulations of 1914 of being reactionary and of revealing a complete ignorance of modern conditions. Ting, however, maintains that they are an attempt to bridge the transition from old-time small-scale methods to modern large-scale methods. However incomplete they may be from the standpoint of the foreign investor, these mining regulations have secured considerable progress. The lowering of the rate of taxation to within a reasonable percentage of output (1·5 per cent.) has made it no longer necessary to obtain exemption from taxation if mining is to be at all possible and so has enabled the building up of a just and honest administration. Nevertheless, nearly all the big coal and iron mining concerns enjoy reduced taxation[1] and Collins concludes from this evidence that mining development in China continues to be impossible without special privileges.

The lack of available Chinese capital and the restrictions on the introduction of foreign capital undoubtedly restrain the rapidity of mining development in China. But, in order to avoid the evils of a too rapid transformation of the old conditions of life, it is better that the introduction of new methods of mining and of industry should proceed gradually. From this point of view, the mining regulations, however vexatious they may outwardly appear to be, serve a useful function.

Although several of the purely Chinese coalmining enterprises have been quite successful, the most conspicuous success has been experienced by amalgamated companies such as the Kailan Mining Administration and the Fuchung Corporation. Such concerns gain the advantages of foreign experience without their drawback of foreign domination and it is significant that their present success dates from the period of amalgamation. Moreover, these amalgamated companies have the option of becoming purely Chinese at a stated date in the future,[2] that is, when experience of mine administration has been acquired by the Chinese and when the financial stability of the company is assured. These concerns appear to satisfy both parties and it is probably along these lines that the problem of the introduction of foreign capital will be solved.

1. This is more in the nature of reduced or compounded likin charges and is, therefore, a reduction in the taxation of traffic movement rather than of mining as such.

2. The option of purchasing the Kailan Mining Administration outright fell to Chinese interests in 1922 but the right was not exercised.

Chapter IV

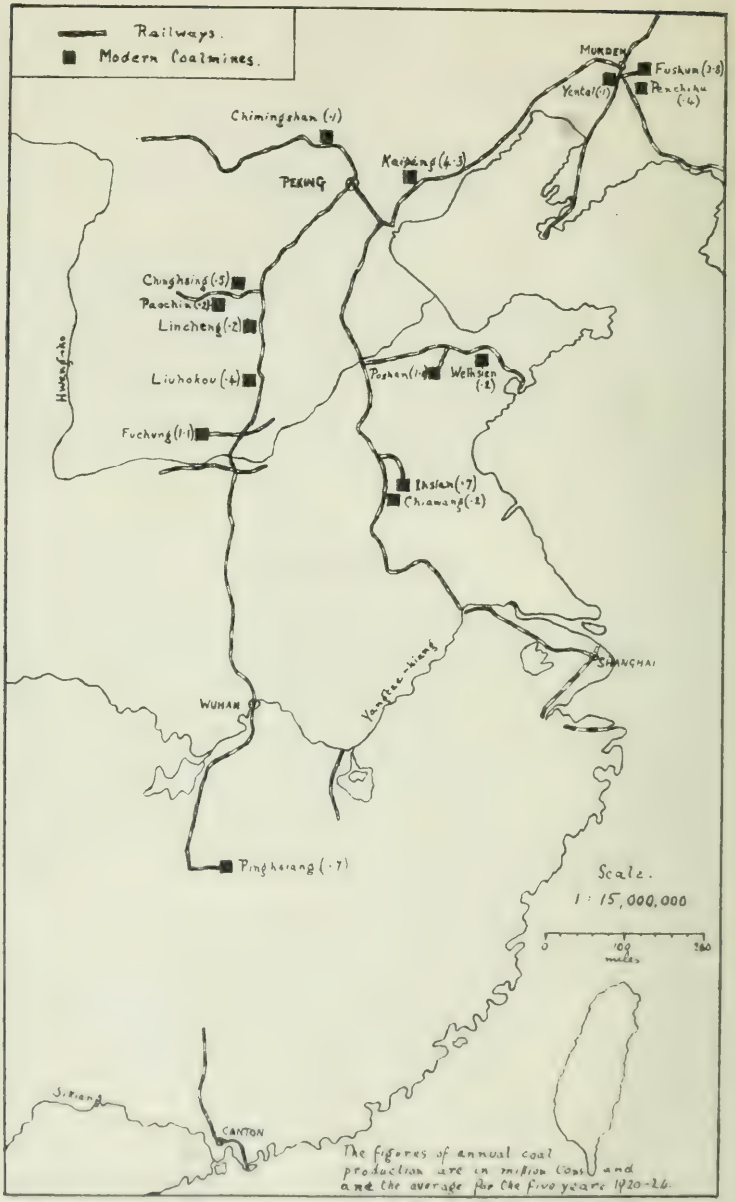
THE REGIONAL FUNCTIONS OF COAL AND IRON IN CHINA

The transformation of the coal and iron industries through the adoption of the large-scale methods of the West has naturally proceeded furthest in those regions of China most accessible by sea and is at present restricted to South Manchuria, to North China apart from its extreme West and to the Yangtze Valley. The West and much of the South retain almost without modification the mining technique and the market conditions of the Old China and this will doubtless continue so long as defective means of communication retard the penetration of western methods.

SOUTH MANCHURIA

The modern mining and industrial development of South Manchuria has issued out of its position on the margins of China within the reach of the expanding powers of Russia and of Japan. The interest of Russia in the coal resources of South Manchuria was confined more or less to the fuel requirements of the railway on which she had based her political penetration of the eastern margins of Outer China. Even for this purpose coal supplies were not essential, for the locomotives of the Chinese Eastern Railway were adapted to burn wood fuel. Japan, on the other hand, has a much more vital economic interest in South Manchuria and especially in its coal and iron resources.

The coal resources of Japan are of no great magnitude and, although they have played an important part in the coal trade of the Far East, will comparatively early approach exhaustion. The most important fields, lying at either end of the Japanese arc, in Kyushu and in the Hokkaido respectively, are of Tertiary age and have each a reserve of round about 2,000 million tons. The Kyushu fields have been intensively worked and their output appears to have reached its zenith, but the development of the Hokkaido fields, as they are more remote, is only just beginning. For a time fully half of the coal output was exported, but since 1900 the export trade has gradually declined owing to the demands of rapidly expanding industries and transportation services within



6.—The Distribution of Coalmining by Modern Methods and its Relationship to the Railway System.

Japan itself. In view of its comparatively small coal resources, therefore, Japan, once an exporter, is likely to become in the future more and more a coal importer, dependent on the coal resources of her neighbour, China. The iron resources of Japan, amounting at the most to but 80 million tons,[1] are infinitesimal and the Japanese iron industry is even now dependent on Chinese iron ores.

Large-scale coalmining in South Manchuria has been confined to those fields in the vicinity of the railway. Although their initial location was determined by strategic and commercial rather than by mining and industrial considerations, the railways serve an essential function as distributers of coal production. Moreover, the foreigner holds more exclusive rights over mining within the railway zone. The fields along the edge of Liautung, accessible from the arterial railway to Port Arthur were, therefore, the first worked and were organized by the South Manchuria Railway (S.M.R.) originally, of course, to satisfy its own needs. Later large-scale coalmining, on the Penchihu field along the railway to Antung has, however, been independent of the S.M.R., and has been financed jointly by Chinese and Japanese capital. The attempts to work the fields along the western margins of the South Manchurian Plain have been under purely Chinese auspices, but there are indications that they may in the future be worked by bigger concerns already developed in South Manchuria or in North China. The fields along the edge of Liautung are at present clearly the most important.

Due largely to the great thickness of its mainseam, much of which is adapted to open quarrying and which is in strong contrast to the very thin seams of the Permo-Carboniferous fields, and to its proximity to the railway focus of Mukden, the Fushun coalfield dominates the coal trade of South Manchuria. It supplies the railway with its locomotive fuel and industry with its power.

Though strung out in the towns along the railways, industrial development is concentrated, firstly around Mukden, the railway focus, and Fushun, the power centre, and secondly around the commercial outlets of which Dairen is the most important. The form taken by industrial development in these centres bears witness to the organized interdependence of agriculture and industry, the beginnings of which are characteristic of modern South Manchuria. Of this, the cultivation of the soya bean and its manufacture, concentrated in the vicinity of the ports, into bean oil and the fertilizer beancake is the best example. On the Fushun coalfield there have arisen several by-product industries, notably the manufacture of the fertilizer ammonium sulphate from Yentai iron pyrites and the nitrogen of Fushun coal. Wheat farming and flour

1. Imperial Mineral Resources Bureau. Iron Ore, Part 8, p. 33.

milling, though much more important in North Manchuria, are of some importance along the railway zone. The distinctive industrial development of South Manchuria will probably be along these lines rather than in the direction of the textile industries. A small cotton industry and a still smaller woollen industry, it is true, are in existence both mainly in Mukden, and under Japanese auspices may attain some considerable development.

The market for Fushun coal is far from being confined to South Manchuria. North Manchurian industry has since its inception been dependent on Fushun coal, but the development of the coal resources of North Manchuria, now just beginning, will probably limit this market in the future. Over half of Fushun's production is exported to Japan and along the China coast, or else serves as a bunker coal for the shipping of North China. In fulfilling these functions it competes with coal from the Kaiping field.

The development of the coalfields of the western margins of the plain of South Manchuria to serve more than a purely local market is only just beginning. The Tayaokow field on the Liauhsi ridge at present supplies 20 per cent. of the coal market of Liauhsi and the Peipiao field nearby is being organized for mining on a large scale.

The iron industry of South Manchuria is located either on or in the vicinity of those iron fields, Anshan and Miaoerhkou, which are at once best suited for large-scale mining and accessible from the railway. The Miaoerhkou ores are smelted on the Penchihu coalfield nearby with Penchihu coke which, though high in ash and sulphurous, is superior to the Tertiary coke of Fushun. The coke consumption in the furnace, per ton of pig-iron produced, compares unfavourably, however, with that of Pinghsiang coke in the Hanyang iron industry of the Yangtze Valley. The Anshan ores are smelted with Fushun as well as with Penchihu coke, but the location of the industry on the ore field is evidently determined by the low grade of the ore.

This iron industry functions in a manner characteristic of the earlier stages of development. No export of ore, such as has arisen from the Yangtze fields, ever seems to have existed from South Manchuria, for its ores are too low-grade to warrant long-distance transport. Its main function at present lies in the export of pig-iron to the steel works of Japan, and in the supply of the railway engineering shops with their raw material. The general iron market of South Manchuria is still supplied by native smelters and by foreign manufactured iron, just as the domestic coal market is still largely, though by no means entirely, supplied by small native mines.

It is probable that this export of coal and iron to Japan will continue, whatever the political status of South Manchuria in the

future. Japan has need of South Manchurian resources and the commercial connections now being formed cannot easily be broken. The nature of the reciprocal trade will, of course, change as the development of South Manchuria proceeds.

7.—The Distribution of Modern Ironworks.

NORTH CHINA

North China, the possessor of the richest coalfields of the Far East, is the centre of most of the coalmining activity of China. This concentration of coalmining in North China is not simply the product of its wealth in coal, for large-scale coalmining has developed from other causes, namely, the existence of modern means of communication and the penetration of foreign influences along them. The Chinese railway system radiates outwards from Peking along the edges of the Plain and across the Western Hills[1] to link the capital with the regions outside North China and to bind North China itself more closely together. These trunk railway lines, penetrating southwards to the Yangtze Valley, to both the Delta and the Central Basin, northwards to South Manchuria, eastwards to the Shantung coast and westwards to the Mongolian border, have stimulated large-scale coalmining in nearly all the fields peripheral to the North China Plain.

1. The Hsishan or Western Hills of Peking.

The Peking Basin.

Of all the coalfields of China that of Kaiping has attained the greatest development.[1] The predominance of its coals over all other Chinese coals in Far Eastern markets has been the product, in addition to their quality, of certain features of its geographical situation. Being near the seaboard and accessible from Tientsin, the port of North China, it was from the first assured of a bunker market and was later in a position to develop an export trade along the China coast, especially when it acquired the ice-free port of Chinwangtao. Further, being near the railway focus of Peking, it is situated strategically for the distribution of its coal by rail.

Kaiping coal[2] serves, of course, industrial development on the coalfield itself and in the cities of the Peking Basin, Tientsin and Peking. The nature of the latter's industries has issued essentially out of the function of the Peking Basin as the commercial outlet of the pastoral North-West of China and of the agricultural western part of the North China Plain. Leather tanning and carpet and rug making, the latter more important in Peking, are illustrative of the connection with the North-West and Mongolia. The growth of a cotton industry of factory magnitude, especially at Tientsin, bears witness to the relationship with the western part of the Plain, a cotton field of growing significance.

The trend of development at Tangshan, the industrial centre of the coalfield, is somewhat different. Kailan coal is not simply a steam-raiser, for it yields a coke suitable for blast furnace practice. Coke is manufactured, therefore, at Tangshan and finds a ready market in the iron industry of Japan. There is an associated manufacture of firebricks from the fireclays of the coalmeasures and these again are exported. Engineering works too are being attracted increasingly to this industrial centre.

Besides being distributed inland by rail, Kailan coal is exported to all over the Far East. This export has made Chinwangtao the largest coal-exporting port of all the Far East. The export is divided equally between foreign export to Japan, Korea and the Philippines and export coastwise to Chinese ports. Japan takes about half of the foreign and Shanghai about half of the coastwise trade.

In this export trade Kailan coal experiences the competition

1. Since 1923, however, the production of Fushun has gone ahead of that of Kaiping. Their output in 1923 was 4·8 M.T. for Fushun and 4·5 M.T. for Kaiping and in 1924 4·0 M.T. and 4·3 M.T. respectively. The comparative restriction of Kaiping's output has been due to its position in the battleground of the Peking Basin.

2. It is known commercially as Kailan coal, from the Kailan Mining Administration, the amalgamated company working the Kaiping coalfield.

of Fushun, but as this did not arise until towards the end of the decade 1900-10, Kailan coal had got well entrenched. The competition between them is not elastic, for ship's boilers adapted to the use of the one cannot successfully utilize the other. At present Kailan coal is delivered in Shanghai, for example, at a price below Fushun.

The anthracitic Fangshan-Wangping coalfield is worked to some extent by modern methods and supplies the railways with locomotive fuel but more especially a domestic market. The anthracite of the Shihmenchai field, though again worked in part by modern methods, is still consumed only for domestic purposes.

The only iron ore deposit in the vicinity worked in the interests of a modern ironworks is that of Hsuanlung near to Hsuanhua, on the Peking-Suiyuan railway. Its ores at one time travelled by rail to Hanyang, but this was possible only during the boom period of the Great War. A plant to smelt these ores with Liuhokou coke has recently been erected near Peking.[1] The establishment of blast furnaces at Chinwangtao to be fed by Kailan coke has also been contemplated. It would have the choice of ores from three iron fields, the low-grade Archaean ores nearby, the Pre-Cambrian ores of the Peking Grid and the contact ores of the Yangtze Valley, which could be cheaply imported as return cargo in colliers engaged in shipping coal to the Yangtze Delta. This project seems to offer a cheaper assemblage of raw materials than any other in China. The iron market afforded by foundries in all these industrial centres and by the railway shops of Tangshan is at present supplied by Hanyang pig-iron.

The Peking Grid.

Large-scale coalmining is practiced within the Peking Grid by only one concern, on the Chimingshan field near Hsuanhwa, and was introduced, as elsewhere in China, to satisfy the fuel needs of the railway, in this instance of the Peking-Suiyuan line. Of the other fields only one, in the vicinity of Tatung, has developed a more extensive coal trade than existed in the Old China. It exports its anthracite down the railway as far as Peking and Tientsin.

The long and difficult railway haulage to the coast and the competition of more favourably situated fields precludes the development of these coalfields for the export trade. Their utilization, therefore, depends on a market within the Peking Grid itself. The domestic market is satisfied by the small mines and the fuel needs of the railway do not require very extensive mining development for their satisfaction. The extension of large-scale coalmining hence awaits industrial development.

1. It is in the hands of the semi-official Lungyen Mining Administration.

Such industrial development will almost certainly take the form of a woollen manufacture working up the products of the vast pastoral zone of North-Western China and Inner Mongolia, for which the Peking Grid has provided the immemorial gateway into the more densely peopled lowlands of China. The beginnings of such a woollen manufacture with more than a purely local significance have already arisen at Tatung, whose goods find a market throughout the Peking Grid. Richthofen long ago forecasted such a development in the vicinity of the Tatung field. A similar industry has arisen in the Taiyuan basin farther south but again along the border of the pastoral zone. The future of these woollen industries on the coalfields fringing the North-West is assured even though Mongolian wool may be increasingly diverted northwards to the Chinese Eastern Railway. The market for woollen goods in China, formerly almost infinitesimal by reason of the exclusive use of cottons and silks, is rapidly expanding and the gown of the North Chinese, for example, is being made increasingly of woollen cloth.

South Shansi.

The fields of the South Shansi group are now, as in the past, at unequal stages of development. Because of its iron industry and its export of coal into the Plain, the "Anthracit-Terrasse" remained the most highly developed until the coal and iron industries began to be transformed through contact with the West. The movement at present is towards the predominance of those fields, both bituminous and anthracite, along the foot of the Taihangshan and traversed by the Peking-Hankow trunk line. The influence of the railway is again in evidence.

The bituminous fields of the northern part of the zone along the foot of the Taihangshan are worked by large-scale methods at four different localities.[1] Their aggregate annual production, now well over one million tons, is only about one-quarter of that of the Kaiping field. The concerns working these fields were originally established to feed the Peking-Hankow railway and their history largely resolves itself into competition for the railway market and for preferential rates for the transport of their coals. Indeed, the northern part of this railway may be considered as in essence a mineral line. Their growth of output bears witness to the expansion of their market so that they now feed industrial development along the railway and even away in Wu Han, the focus of the Central Basin. This function is likely to become more and

1 The companies concerned are the Chinghsing, Lincheng and Luhokou whose output in 1921 was 0·58, 0·28 and 0·25 M.T. respectively. Luhokou is now under the financial control of Lincheng.

more important in the future. The Plain immediately to the east of the coalfield and comprising Western Shantung and the adjacent parts of Chihli and Honan is the most important cotton field in North China, growing American as well as indigenous shorter-stapled Chinese varieties. The bulk of the crop is still manufactured into cloth by hand-worked machines, but an increasing proportion by a power-using industry growing up along the railway, especially about the point where the Hwang-ho enters finally on to the Plain, and at Tientsin, the great marketing centre for the raw cotton of North China.

The coals of part of this bituminous field, those from the Liuhokou mine at any rate, furnish good metallurgical coke which is at present consumed mainly by blast furnaces and foundries in WuHan. If it is possible in the future to work the Shansi iron ores, coking coals occur, therefore, nearby.

The anthracite fields of the foothills of the southern Taihangshan[1] are worked, as well as by old-time Chinese methods, on a large scale by one concern, the Fuchung Corporation. Its output is consumed all over the western part of the Plain, and in common with anthracite all over China, almost entirely for domestic purposes. It is distributed over the Plain and reaches Tientsin by means of the old waterways rather than by the railway. Both in its function and in the mode of its distribution anthracite is, therefore, quite distinct from bituminous coal and is linked on to the conditions characteristic of the Old as bituminous is to those of the New China. The better lump coals, shipped coastwise from Tientsin, find a wider and expanding market in most of the treaty ports of the Chinese coast. This again illustrates the function of Tientsin as the commercial outlet of the western North China Plain.

As the boilers of steamships and of factories have been adapted to the use of bituminous coal from Kaiping, Fushun and Japan, the earlier utilized on a large scale, it is difficult for anthracite to acquire a market as a steam coal. Fuchung anthracite is used in Shanghai, for example, only to a limited extent for boiler practice. The whole of the South Shansi group of fields suffers, moreover, from a greater difficulty of access to the seaboard and its coals, therefore, are only just beginning to be shipped from the ports.

On the " Anthracit-Terrasse " only one mine,[2] along the railway linking Taiyuan with the Peking-Hankow trunk line, is worked by modern large-scale methods. It supplies the railway with most of its traffic. Elsewhere old-time methods persist and satisfy the

1. The Taihangshan here swings E-W and faces the hills of West Honan across the Hwang-ho. Farther north, where the coalfields at its foot are bituminous, the Taihangshan trends N-S.

2. That of the Paochin company near Pingting.

domestic market and the dwindling iron industry.[1] On account of the present restriction of the anthracite market, the development of the " Anthracit-Terrasse " will not be very rapid during the next few decades. It is likely, however, to experience some industrial development in the future focussed probably as in the past around Pingting and around Tsechow, but of its nature and of its importance there is as yet no indication. An export of coal will, no doubt, in time develop to industrial centres arising around the edges of the Plain, to the seaports where bunker coal is in demand and perhaps to serve the general coal market of the Far East. Impressed by the enormous potentialities of the Shansi anthracite coalfield, of which the " Anthracit-Terrasse " forms only the most accessible part, Richthofen forecasted a revolution in world commerce and in world politics whenever railway communications would be established between it and the seacoast.

The utilization of the concealed coalfields of the " Tsin Plateau " will necessarily be deferred until the zone of the " Anthracit-Terrasse " becomes partially exhausted. The sediments overlying the coalmeasures do not appear to be too thick to prevent their utilization. These concealed coalfields constitute a reserve of great potential importance but of no actual economic value for a long period.

The bituminous fields of the west have not yet experienced large-scale coalmining, and the coal market, mainly domestic and that furnished by small-scale industry, is satisfied by small mines. But the introduction of large-scale industry, now just beginning, will create a market for mining on a larger scale. It would appear that such industrial development will take the form of textile industries, both cotton and woollen. Cotton cultivation in Shansi is most important in the Fen-ho valley and a cotton industry is arising at various points along it. West Shansi is an important pastoral zone and the Taiyuan basin a collecting centre for the pastoral products of the North-West of China. The manufacture of wool and the tanning of skins by modern methods in the basin has already begun.

The coalfields of West Honan to the south of the Hwang-ho as yet serve no more than a local market. The anthracite of the fields along the southern edge of the Hwang-ho flood plain is very friable and cannot compete with the lump anthracite of Shansi proper. The bituminous Lushan-Juchow coalfield has a greater potential value and may fulfil some industrial function. Its coking coals, if of sufficient quality, may help to supply the iron industry of the Yangtze Valley. In the general market, however, these

1. Shockley suggests an annual coal consumption for the whole of Shansi of 5 M.T.

fields will have little hope of competition against the larger fields to the north.

In spite of their comparative purity—they contain 50 per cent. of iron—the iron ores of Shansi are unsuited to modern large-scale blast furnace practice, because of their occurrence in beds too thin for working by modern mining methods and because of their distribution in small masses necessarily of varying chemical composition and so unsuited to large-scale industrial use. At the time of Richthofen's visit to China, the iron industry throughout the world was carried on by small plants which could have treated even the Shansi ores on an economic basis. But the conditions underlying iron and steel production have changed since then.

North Shensi.

The North Shensi coalfield, buried deep under the loess, is worked at but few points and at these solely for local domestic consumption. It can look forward to no industrial development of any significance in the immediate future, during which industry will have become firmly rooted around the North China Plain and on the coalfields of South Shansi and the Peking Grid. Some industrial development may be expected and is even now taking place in the more fertile loess basins of the Wei-ho valley, which is outside the coalfield proper, but it will remain strictly subordinate to that farther east.

North Shantung.

Until 1914 Northern Shantung formed a base for the German and since 1914 for the Japanese penetration of China. It has in consequence experienced a comparatively intense development of its coal and iron resources especially, as Japan had greater need of them, in the later period.

Large-scale coalmining[1] has been introduced on to the two fields of Weihsien and Poshan. Small mines still persisting on these fields and still supplying part of the domestic market are gradually disappearing. These fields supply the railway and domestic markets but those functions most significant of future growth are in relation to industrial development and to the bunker and export markets of Tsingtao.

Industrial development, strung out along the railway, is concentrated on Tsingtao, the point of entry of foreign penetration,

1. The coalmining company was in the first instance purely German. In 1914 Japan, who had expelled the German forces from Shantung, took it over. After the Washington Conference of 1922 a new company was formed which is in effect a joint Sino-Japanese concern.

and on Tsinan, a railway focus. The cotton industry is at present most important at Tsingtao where it is almost entirely in Japanese hands. The industrial development of Tsinan issues in the main out of its function as the market centre of the plains of West Shantung. It is already an important flour milling centre and is developing bean oil and cotton industries. In addition to these, long-established household silk reeling, focussed in Chefoo, is beginning to be transformed into a steam filature industry, but its transference across to Antung in South Manchuria, which was originally tributary to the Chefoo industry, is no remote possibility.

The coals from both the Weihsien and Poshan fields are good steam-raisers and have an assured market for bunker purposes. Richthofen forecasted that Kiaochow Bay would dominate the bunker market of the North China Seas and it has undoubtedly a favourable position for this purpose. The coal export from Tsingtao goes primarily to Japan, a witness of Japanese influence and of Japanese needs, largely for consumption as a bunker coal, and secondarily to the Yangtze Delta to feed industrial development. The further expansion of the export market, which may even, as some speculate, include sometime the Pacific coast of North America, awaits the improvement of railway and harbour facilities.

The iron ores of Tiehshan are smelted nearby in the Chinlingchen ironworks along the railway, with Poshan coke. Its pig-iron is non-phosphoric and is hence suitable for use in the acid steel plants of Japan. No attempt was made to work these ores on a large scale until Japan, dependent on imported iron ores, acquired an interest in Shantung. But, as only one ore body is known, it cannot form a permanent source of supply for anything but a small industry.

The South-Eastern Quadrant of the Plain.

The Ihsien coalfield of southern Shantung is worked on a large scale by the Chunghsing company, perhaps the most efficient of all the purely Chinese coalmining ventures. Although established in the days before the railway, its production remained small until the construction of the Tientsin-Pukow line, which it supplies with fuel and from which it has obtained preferential rates. Its output has since grown rapidly. The most important function it now serves is the supply of the industrial coal market of the Yangtze Delta, which it furnishes with 20 per cent. of its consumption. Its coals are, in addition, beginning to feed the bunker market of Shanghai. The Ihsien coalfield is linked, therefore, rather with the Yangtze Delta, whose coal market is far in excess of its local supplies, than with the rest of North China, whose industrial and commercial centres are already well provided for by other fields.

The Tungshan or Chiawang field, farther south but again in touch with the railway, is worked by large-scale methods and its output is steadily increasing.

Ihsien coal yields a good metallurgical coke and may conceivably in the future help to supply the iron industry of the Yangtze Valley. There are, moreover, iron ores of some importance in the vicinity of the coalfield itself.

THE YANGTZE VALLEY BELOW THE GORGES

Mining and industrial development in North China have depended on and have proceeded in intimate association with the construction of the great trunk railway lines. But in the Yangtze Valley a trunk line of communication was already at hand in the river itself and industrial development had not to await railway construction. While the Yangtze Valley has experienced a greater development of industry than any other region of China, railway construction in it has been confined, therefore, to a few short stretches of line. Yet its main coalfields, situated as they are in the hills away back from the arterial waterway, still depend on railway construction for their utilization. With one exception,[1] and that linked on to a trunk railway line, large-scale coalmining has not, therefore, made much progress in the region of the Yangtze Valley and interest is centred mainly in the convergence of coal supplies on to the two focal basins, the Delta and the Central Basin of China.

Most of those coalfields of North China which are easily accessible from the sea have developed a coastwise trade in their coals and of this the Yangtze Delta is the main objective. The local coal resources of the Delta are small and, although fairly intensively utilized and in a couple of cases worked by western methods, are insufficient to satisfy its coal market. Its coal market is supplied, therefore, mainly by the coasting trade and import from Japan and, secondarily, by downstream river traffic. The convergence of coals from Japan, Kaiping, Fushun and Poshan—representing the coasting trade—and from Upper Hunan—representing the downstream traffic—on this industrial and commercial region is a significant feature of its economic development. In addition, coals move into the Delta by rail from Ihsien.

The general industrial market of the Delta is supplied almost entirely by bituminous coals and is dominated by Kaiping and Japan, both of which are especially favourably situated for the

1. The Pinghsiang mine.

development of an export trade.[1] Kailan coal will almost certainly remain important, but the movement of Japanese coal into the Delta is likely to decline by reason of the partial exhaustion of Japan's own coal resources. The quota contributed by the other bituminous fields will increase whenever their coals can be delivered at prices comparable to those of Kailan and Japan. The anthracite coals are restricted to the domestic market and the downstream traffic from Hunan is exclusively of this nature.

The Yangtze Delta, a fertile and densely peopled plain country at a focus of routes and in closer contact that any other region of China with the material civilization of the West, at present forms the chief industrial region of China. The contact with the West is most intimate at Shanghai and on it industrial development is concentrated. The raw materials for its cotton, silk and milling industries are being drawn increasingly from the Delta's own fertile plains. Two-thirds of the whole cotton industry of China is concentrated in the Delta and one-half in Shanghai alone. Apart from Shanghai, cotton mills are scattered throughout the Delta region but more particularly along the railway towards Nanking. The cotton industry at Nanking itself, however, is still in a hand-loom phase. The distribution of steam silk filatures is somewhat similar, being mainly in Shanghai but strung out also along the railway as far as Chinkiang.

The growth of industry, although apart from ironworking essentially of the same type, has not proceeded as far in the Central Basin as in the Delta and its coal consumption is, therefore, much smaller. The coal market afforded by the WuHan industries and the Yangtze steamers is supplied by the bituminous coals of Pinghsiang and of the fields along the foot of the Taihangshan, which are both linked to WuHan by rail. The domestic market of the Basin is supplied from its own western margins and from the Leiyang field of Upper Hunan. In addition, WuHan consumes Fuchung anthracite moving south from North China along the Peking-Hankow railway. There is, therefore, the same convergence of coals on to the Central Basin, though on a smaller scale and though less complete by reason of the exclusion of the coastwise trade, that is expressed so fully in the Delta.

Even the present distribution of cotton mills, immature as it is, permits of the indication of the major cotton manufacturing regions of the New China. Each of these major regions, the Yangtze Delta, the Central Basin and the fringes of the North China Plain, have developed their cotton manufactures in the market centres of

1. The Kyushu coalfields, from which the Japanese export originates, are close to the shore line and at the southern end, nearest to China, of the Japanese arc. They have long been organised essentially for the export of their coals.

the cotton growing areas and in particular in their main commercial outlets. But some differentiation between them is likely to arise. Although the heavier summer rainfall of the Delta unfits it for the growth of American upland cotton, which can be successfully cultivated in the Central Basin and in the North China Plain, yet its indigenous varieties, at present of shorter staple, are capable of considerable improvement. But, of greater importance in the localization of a cotton industry, the dry winters of North China restrict cotton spinning to the coarser yarns. It appears probable, therefore, that cotton spinning and, in particular, fine cotton spinning will become localized in the main in the more humid Yangtze Valley and that the North China industry will remain of a coarser type.

The only large-scale coalmine of any conspicuous importance in the whole of the Yangtze Valley region is Pinghsiang, high up on the Hunan-Kiangsi border but in communication with the commercial focus of WuHan by what is destined to become the trunk railway line southwards to Canton. The original reasons for its utilization and the basis of its present importance are, firstly, the quality of its coke, the best yet known in the Far East, and secondly its comparative accessibility from WuHan, in which almost the whole of its output not utilized on the field itself is consumed.[1] And the industrial activities of Pinghsiang—the manufacture of coke, of firebricks and of engineering materials—comparable in type to those of Tangshan on the Kaiping coalfield, have all issued out of its relationship to WuHan and in particular to the iron industry of Hanyang.

The utilization of the iron ore bodies strung along the line of the Yangtze in its course from the Central Basin to the Delta has been confined to either extremity. They were earliest worked in the west, in conjunction with the iron and steel plant set up at Hanyang, and the most important ore workings are still at this western end. During the last decade the ore bodies of the eastern extremity, situated nearest to Japan, have been worked for export in relation to the Japanese iron and steel industry, but their ores are now beginning to be consumed by an ironworks in the Delta itself.[2]

Tayeh ores of the western extremity and Pinghsiang coke form the basis of the Hanyang iron industry. Both raw materials are of as good a quality as any in the Far East but the coke, essentially on account of high transportation charges, is much the more expensive of the two. In this respect Hanyang compares unfavourably with Penchihu whose industry is located on the

1. In recent years the output of Pinghsiang has been steadily declining and fears are beginning to be entertained for its future.

2. The Putung Iron and Steel Works of Shanghai.

coalfield itself.[1] Moreover, coke consumption in the furnace is higher than that, for example, in the Pittsburg iron and steel industry of the United States, being respectively 1·2 and 1·0 tons of coke for every ton of pig-iron produced. These figures are comparable for the ores smelted in both cases have similar percentages of iron.

As yet pig-iron is the most important output of the Hanyang enterprise and it serves a wide market. It is consumed by engineering shops, foundries and local forges throughout North China and the Yangtze Valley and, as Penchihu has not entered the Chinese pig-iron market, its only competitor has been imported foreign iron. There is, further, an important export of pig-iron, as well as of iron ore, to Japan.

The proportion of pig-iron converted into steel at Hanyang depends on the demand for steel in China, which has until now been chiefly for railway materials. Hanyang has been granted priority in the supply of rails to the Chinese Government Railways, but as railway construction in China has been dormant for the last decade the demand for rails has been small. Other constructional railway equipment such as fish-plates, track-bolts and bridge-shapes have similarly been little in demand. Attempts are, however, being made to acquire a wider steel market independent of railway construction. The steel industry of Hanyang should hence find a growing market when railway construction is resumed, when shipbuilding increases in importance and when constructional steel is more in demand.

For the installation of new machinery, the Hanyang industry has from time to time had to recourse to loans, which in the later period of its history have been made almost entirely by Japan. They are to be redeemed by the sale of ore and pig-iron.[2] Other of the metal-mining industries have contracted loans under similar terms of repayment. Japanese interests now, therefore, dominate the Hanyang industry.[3]

Certain ore bodies[4] have been worked at the eastern extremity

1. Both the ores and coke of Penchihu, however, are of a much poorer quality.

2. Tegengren calculates that it has committed itself to supply Japan with iron ore and pig-iron in excess of the total ore reserves in its possession.

3. The Hanyang ironworks, the Tayeh iron mine and the Pinghsiang colliery are all the property of the Hanyehping Iron and Coal Company, which is, therefore, one of the most important industrial corporations of China. As its financial position has continued to grow worse, Japanese control has grown stronger and stronger and in the Twenty-One Demands of 1915 Japan attempted to convert the Company into a joint Sino Japanese concern.

4. Those of Taochung in Anhwei

of the Yangtze ore field by small Chinese concerns many of which have bound themselves to long-term contracts with Japanese ironworks. There is a danger that Japanese interests will effect a monopoly of the Yangtze ore fields not by means of actual ownership, from which they are excluded by law, but by the financial control of such ironworks as Hanyang and by long-term ore-selling contracts at pre-fixed prices. By this means the Japanese iron industry has assured itself of much of its iron ore requirements and has appropriated for its own use a good proportion of the total reserve of the Yangtze ore fields. But this danger of Japanese control can be overemphasized and the Hanyang ironworks, for example, can maintain the level of its output only through the demand for its pig-iron from the iron industry of Japan.

Although this iron ore field strung along the line of the Yangtze is dominated by the Hanyang enterprise at the western and by Japanese interests at the eastern end, it feeds other, though much smaller, ironworks in the commercial foci of Hankow and Shanghai. The Hankow works imports its coke along the railway from the Liuhokou mine underneath the Taihangshan edge again from a considerable distance.[1]

The high-grade ores strung along the focal line of the whole region and the comparative accessibility of good coke supplies distributed around its periphery mark out the Yangtze Valley as the seat of at least one of the most important iron industries of the New China. But the growth of the industry will not be rapid until the general iron market expands. It has been calculated that the consumption of iron per head of population is in China only one-hundredth of that, for example, in England and Germany.[2] The capacity of existing Chinese ironworks is amply sufficient to supply the whole of this extraordinarily restricted demand.

SOUTH CHINA

Elsewhere in China the large-scale utilization of coal and iron has not yet begun and the conditions governing the coal and iron market of the Old China remain. But in South China, long in commercial contact with the West, large-scale industry has taken root in several cities along the coast and especially in the Canton Delta. Such industrial development is hence dependent on coals imported from outside the region, from Japan, Kaiping, Fushun

1. The Yangtze Engineering Works, the works in question, is now controlled by the Liuhokou mine.

2. The total annual iron and steel consumption of China amounts to no more than 600,000 tons. See F. R. Tegengren. "The Iron Ores and Iron Industry of China" (*Mem. Geol. Surv. China*), Part II, pp. 396-7.

or Formosa. The production of small mines in South China is consumed entirely by the domestic market and in such small-scale industrial processes as lime-burning.

Industrial development is concerned in the main with the working up of the region's own raw materials, silk and sugar. Sericulture is practised in all the valleys converging on the Canton Delta, in which the steam filature silk industry, the most important in the whole of China, is concentrated. The beginnings of sugar refining have been established at Hongkong and it offers possibilities of considerable growth. In view of the coal market afforded by these industries some of the fields are installing modern mining machinery and it is considered that further industrial development will have perforce to await the utilization of the region's own coal resources. The coal market of the Canton Delta is likely in the future, therefore, to be supplied increasingly from Kwangsi and from the Shaochow and perhaps also from the Pinghsiang fields along the Hankow-Canton railway.

In the basins along the coast to the north of the Canton Delta the development of industry has exhibited no peculiar emphasis and it appears likely that it will adapt itself to serve the general needs of each basin. Although accessible by sea, these basins have remained more or less isolated and self-sufficient. Industrial development in them is proceeding at a slower rate than elsewhere along the China coast and they suffer from a depletion of population attracted by the more immediate possibilities of Malaya.[1]

The utilization of the iron ore resources, admittedly rather small, on any large scale has not yet begun. The foundries and the shipbuilding of Hongkong are hence dependent on imported American and European iron and steel. They will always perhaps remain dependent on iron smelting outside the region.

THE BASIN OF SZECHUAN

The Basin of Szechuan stands isolated in the far west of China and draws within its orbit the mountain country of its periphery. It enjoys, therefore, not only the resources of its own fertile plains but also the pastoral products of its borders. The nature of its industrial development, just beginning to enter on a factory phase, bears out these features. The industry most extensively practised is silk-reeling, typical of the warmer southern half of China. Cotton spinning and weaving are still household industries. The skins and wools of the pastoral zone around its borders already form

1. *Commercial Handbook of China* (Department of Commerce, U. S. A.), Vol. I, p. 305.

the basis of an important leather and conceivably in the future of a woollen industry. The primary function of Szechuanese industry will most probably be to serve the varied needs of the region itself and of its borders and it is likely on that account to exhibit a variety unattained elsewhere in China.

Coalmining is at present only on a small scale and serves a market mainly domestic but including that created by small-scale industrial processes of which the most important is the evaporation of brine. Coal is so widespread that it can always be worked locally for household consumption and its quality is not sufficiently high to repay long-distance transportation. Large-scale mining will be dependent on the market afforded by industry, by river steamers and conceivably in the future by the railway. The steamers which used to bring their bunker coal up the Yangtze from outside the province, now replenish their bunkers from Szechuanese mines.

Industry is located on the Chengtu plain, the most densely peopled part of Szechuan and in contact with its mountain rim, and in the several towns along the main river valleys, but especially along the Yangtze, which is in easier communication with and more intimately participates in the life of the rest of China. Szechuan will, however, always remain remote. Both of these industrial regions, in the Chengtu plain and along the Yangtze, are close to the edges of the basin, where coalmeasures rise to the surface.

THE HIGH SOUTH-WESTERN PLATEAUX

As coal is widespread over the region of the High South-Western Plateaux of Yunnan and Kweichow, mining is carried on solely on a small scale and at the point of consumption. The market is mainly domestic and even ore-smelting utilizes charcoal rather than coke or coal. But the woodland accessible for charcoal-burning is becoming depleted and the revival of ore-smelting, now decadent, awaits the transference from charcoal to coke. De Launay looks forward to the rise of metallurgical industries based on ores of copper, lead and zinc and perhaps iron. Copper, the dominant member of the group, would probably focus the industries arising from them on N.E. Yunnan. It is not clear whether iron would form an important constituent of this group of industries for the richest iron ore bodies, even if of workable size and nature, appear to lie away to the east of the coke supplies and are perhaps inaccessible from them.

On the basis of experience elsewhere, it is probable that most of the coalseams of the High Plateaux, being thin and yielding coals of but medium quality, can be profitably worked only by means

of adits driven in from the outcrop along the hillside. This is possible over the greater part of the region. Where mining can proceed only by shaft sinking, the three-foot seams alone are economically utilizable.

As the region consists of infertile and thinly peopled mountain country, it is not likely that extensive manufacturing industries will arise, in the near future at any rate. It appears probable that metallurgical industries will prove to be its peculiar form of industrial development. Yet its position and character are unfavourable to the development even of these. The whole region lies on the margins of China and has been only imperfectly assimilated into it. It is tapped by a railway from French Tongking and it may on this account be drawn more and more within the orbit of French influence. It is conceivable, therefore, that whatever industrial development it will experience in the future will be directed by and will proceed in the interests of Tongking.

In conclusion it will be well to draw together one or two threads of argument. The general features of the relationship of the several major regions of China to each other and to the neighbouring lands of the Far East are already clear. South Manchuria in the north and, though less clearly, Yunnan and Kweichow in the south seem to fall away from the rest of China and to be drawn in some measure within the orbit of Japan and French Tongking respectively. The Basin of Szechuan again stands apart and pursues almost an independent life. The core of China is constituted by the regions of North China, the Yangtze Valley and South China, but these differ from each other from several points of view and not the least clearly in the matter of coal and iron. North China is the possessor of at once the most valuable coalfields and the most intense coalmining activity, but it does not consume all its own coal production. It helps to feed the coal market of the Yangtze Valley and the South China coast, both devoid of nearby coal supplies, and is developing a growing export to Japan. In the case of iron, mining activity has had rather the reverse regional emphasis, but the iron industry of North China is likely to experience considerable expansion in the near future. Even more than with coal, there has developed an export of iron to Japan.

Japan, having a small area, is dependent for many of her material requirements on her more bulky neighbour, China. She is even now dependent on Chinese iron ores and is likely to become increasingly dependent on Chinese coal. Japan has desired to acquire a more secure hold over these resources and this desire almost reached its consummation in the Twenty-One Demands presented to China in 1915. But the menace of Japanese control has now sunk into the background.

The Pacific is often marked out as the scene of the world's future commercial and political rivalry, in which, no doubt, coal and iron will play an important part. China has incomparably the greatest resources in coal of all the Pacific lands[1] and will certainly dominate the coal market of, at any rate, the Far East. Even the western coasts of the Americas, not having accessible coal resources of their own, may provide a market for Chinese coal, but Australasia and the East Indies are likely to be supplied by their own coals and from India. Though not so overwhelmingly, China has also the most important iron resources of the whole Pacific rim. The laterite ores of the East Indies are her nearest competitors, but these are imperfectly explored and their reserve may be overestimated.

Although not inexhaustible, China's coal resources are amply sufficient to meet her own needs and those of the Far East and, in spite of the fears of the Geological Survey, her iron resources seem sufficient to supply the requirements of her own, but not, however, of her neighbours', iron industries.

1. China's coal resources are more in the order of magnitude of those of Europe than of those of North America. The figures submitted to the International Geological Congress of 1913 are China 994,987 M.T., Europe 747,508 M.T., and North America 2,261,525 M.T. These are exclusive of sub-bituminous and lignite, of which North America again possesses far and away the most abundant resources. The figures for Europe and China are more comparable than might appear, for those of Europe are based on much more exact data than those of China.

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